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I. H. C. Foundries in France Rebuilt

How the Casting Shops in the Factory of the International Harvester Co. Near Lille Have Been Re-equipped and Again Organized for Operation After Four Years of War

BY H. COLE ESTEP

CROIX-WASQUEHAL near Lille with its quaint streets and red brick houses overhanging the sidewalks, breathes the very spirit of an old French village. And although scarred with the tragic aftermath of the great war, its life has again fallen into the old grooves with the wooden shoes clicking over the cobblestones much as they did a thousand years ago. But if you follow them down the Avenue Georges Hannart nearly to the Rue de Wasquehal, and turning into the main gate of the big works of the *Compagnie Internationale des Machines Agricoles* bear sharply to the right into the gray-iron foundry you find yourself suddenly transplanted four thousand miles into the heart of the United States. Here is an American foundry with American equipment, methods and atmosphere turning out some fifty tons of castings a day in the north of France. The explanation lies in the fact that *Cie. I. des Machines Agricoles* is the French pseudonym for our own International Harvester Co., with its headquarters at Chicago and numerous plants throughout the

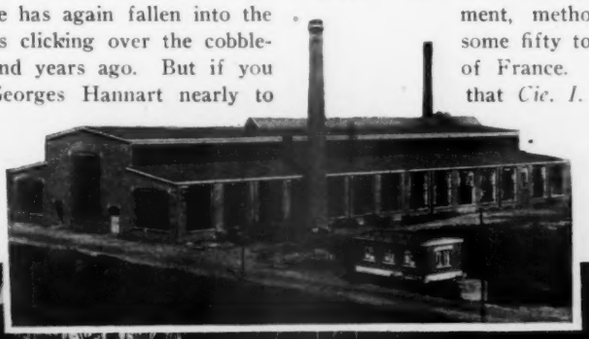


FIG. 1 (ABOVE)—MALLEABLE CASTINGS FOR THE CROIX-WASQUEHAL PLANT ARE MADE IN THIS MODERN STRUCTURE FIG. 2 (BELOW)—THE GRAY-IRON SHOP WAS CONVERTED INTO A MILL FOR ROLLING CORRUGATED SHEETS FOR TRENCH CONSTRUCTION

The author, H. Cole Estep, is European manager for THE FOUNDRY.

FIG. 3—THE YARD ALONGSIDE THE GRAY-IRON SHOP SHOWING CHARGING-FLOOR ELEVATOR

United States. The foundry at Croix is a part of one of the several factories owned by the International Harvester Co. in Europe, in Russia, Germany, France and Sweden respectively What happened to them all in the last five years may readily be imagined. The entire plant at Croix-Wasquehal was put out of action and almost completely stripped by the German army during the war. It is with the technical features of the reconstruction and methods of operating its two foundries, for there is a malleable shop in addition to the gray-iron foundry, that it is proposed to deal in this article. These two shops have passed through the valley of the shadow of death and out again into abundant life. Herein lies a story, romantic in its setting and incident and instructive in its technical aspects.

The village of Croix-Wasquehal is in the department of Nord, France. The town in reality is a suburb of Lille with which it is connected both by steam and electric railroads. It is about four miles distant from the center of Lille. For four years the front-line lay only a few kilometers on the opposite of Lille from Croix. The Harvester company's works was within the sound of guns all the time, but was not directly damaged by military action. The French company under whose auspices the plant is operated is capitalized at 5,000,000 francs; all of the stock, of course, is controlled by the parent company in the United States. The factory is equipped to build mowers, reaping attachments for mowers, rakes, tedders, spring-tooth harrows, tongue trucks, etc., and to make binder twine and other miscellaneous agricultural implements and spare parts. The capacity of the plant under normal conditions is 75,000 machines a year, together with 9000 tons of binder twine. Prior to the war approximately 1600 employes were required including about 250 in the two foundries. The plant was built in 1910. It was practically new, therefore, at the time of the German invasion.

As shown by the accompanying plan, Fig. 10, the factory as a whole occupies two irregular plots of ground separated by the Rue de Wasquehal and Avenue Georges Hannart. The two parts of the plant are connected by a covered bridge spanning the crossing of the two streets. This bridge joins the forge and machine shops. The total area occupied by the works, exclusive of streets, is 97,004 square meters or approximately 24 acres. In other words it is no small establishment.

The smaller of the two tracts into which the property is divided is occupied by the gray-iron foundry; a 2-story main building housing the machine-shop, woodworking and pattern shop, paint shop, assembly department, etc.; the boiler and air-compressor house; pattern vault; and executive offices. On the larger plot of ground is the forge shop, pump house, warehouse, lumber yard, twine mill and malleable castings foundry. Plenty of room has been left for future expansion either by the extension

FIG. 5—IMPROVISED MOTOR CONNECTED TO TRIPLEX HOIST OUTSIDE FOR OPERATING CHARGING-FLOOR ELEVATOR

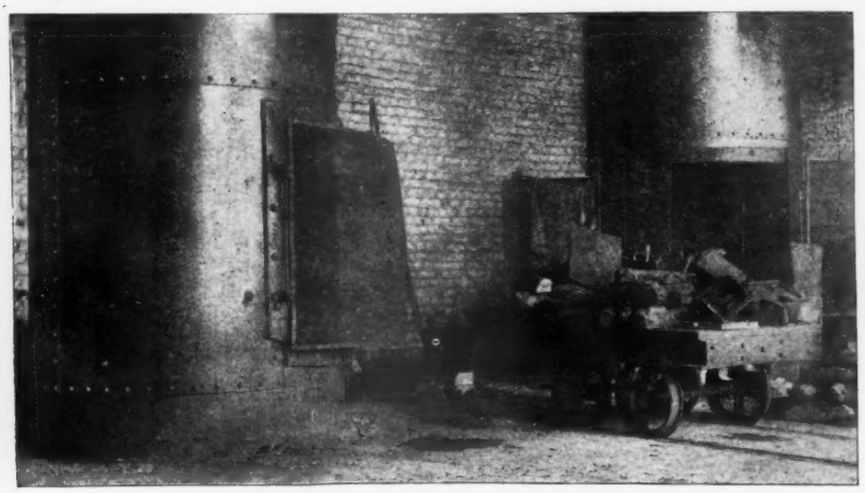


FIG. 4—THE CUPOLA-CHARGING FLOOR LOOKS LIKE A BIT OF THE U. S. A.

of existing units or the erection of new buildings. The gray-iron foundry may be doubled in size by erecting a new structure alongside the one now in use, and the malleable shop can be extended lengthwise in the direction of the lumber yard to nearly half again its present dimensions.

In addition to the covered bridge between the forge shop and main building, the various units in the plant are connected by standard-gage railroad tracks which make it possible to spot cars wherever they may be required for bringing in raw materials, shipping finished products and intra-plant transportation.

The gray-iron foundry is 118 meters in length and 25 meters in width, or ap-

proximately 82 x 387 feet. The floor area is 31,725 square feet inside measurement. It is divided by two partitions into a cleaning room, molding room and core room in the order named. The molding floor area is about 22,200 square feet. A space about the size of the building itself has been left between the foundry and the fence bordering the Avenue Georges Hannart for the storage of raw materials. The pig iron and scrap are taken care of in open bins adjacent to the charging-floor elevator. The sand is stored in a series of brick bins built in the corner of the yard along a curved track as shown in Fig. 10. Another standard-gage track extends alongside the fence for the full length of the storage yard, while parallel to this track but snug against the building is a narrow-gage track for handling iron and coke buggies. At one end of the molding room are the two cupolas. The shop has a melting capacity of about 65 tons a day. The equipment, which includes a full complement of molding machines and other auxiliaries, is such as may be found in any modern casting shop in the United States. Only light castings are turned out and hand cranes therefore are employed. Liberal compressed-air facilities are provided and the machinery is driven by electric motors. The building itself is a steel frame and brick structure with ample window area.

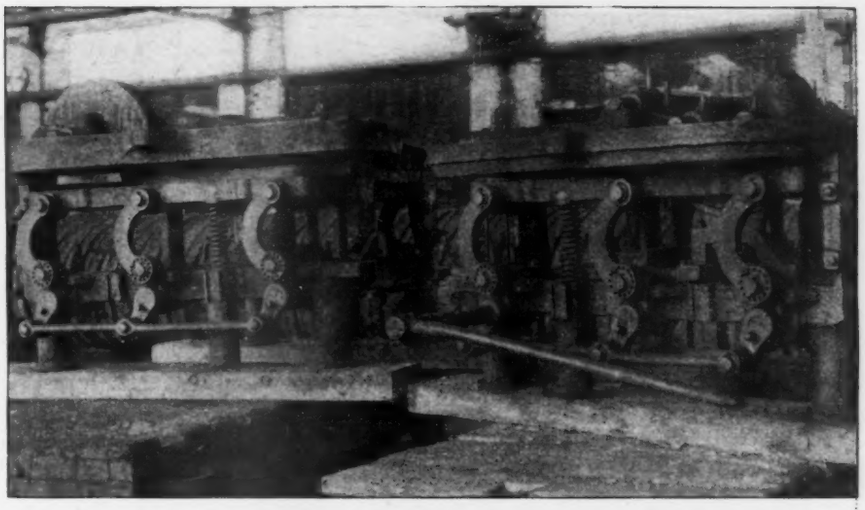


FIG. 7—MOLDING MACHINES FITTED WITH MOWER-FRAME PATTERNS—ALL EQUIPMENT OF THIS SORT HAD TO BE THOROUGHLY OVERHAULED

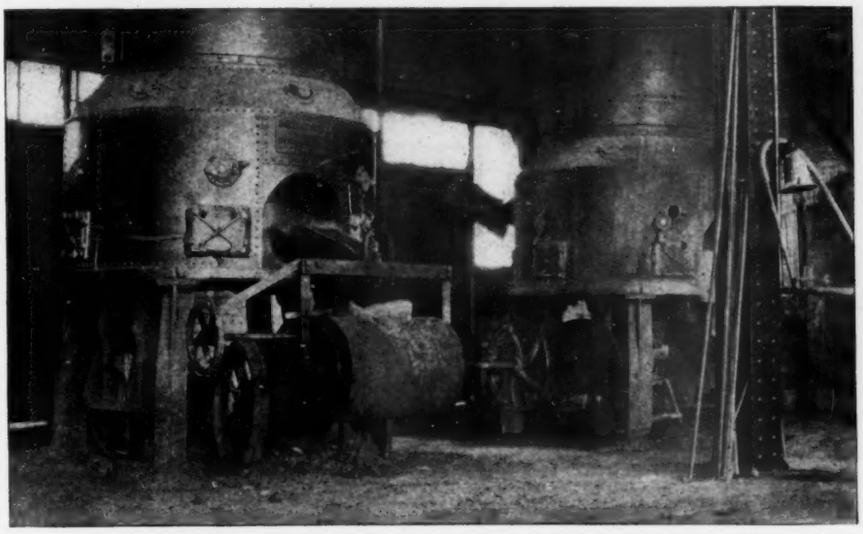


FIG. 6—THE CUPOLAS LOOK NATURAL BUT THE LADLE IS NOT AN AMERICAN TYPE

As shown in Fig. 10, the malleable shop is located at some distance from the gray-iron foundry. This arrangement, which has its disadvantages, is due to the later origin of the former shop. The malleable foundry is of standard monitor construction with 80 per cent of the wall space glass. Both this foundry and the twine mill nearby have more the appearance of American shop structures than any other buildings about the works. The building is 41 meters wide and 88 meters long, or 135 x 289 feet, the floor area being 39,256 square feet. It is divided by two partitions near the middle, leaving a combined melting and molding room at one end about 135 x 145 feet, with a hard-iron cleaning room 35 x 135 feet in the center, and a combined annealing, soft-iron cleaning and shipping room 109 x 135 feet at the opposite end. This arrangement is clearly indicated in Fig. 10, which also shows the location of the air and annealing furnaces with their respective stacks. The air furnace is rated at 12 to 15 tons per charge. It is of standard American design, operating under natural draft with a steel stack 98 feet high. There are two annealing furnaces connected to a 91-foot brick chimney, together with the usual equipment of tumbling mills, grinders, etc. This foundry turns out the usual American black-heart malleable instead of the white-heart product which is usually made in Europe. The shop is designed for an annual capacity of 4000 tons of small malleable castings.

With special reference to its foundries, the foregoing briefly describes the French factory of the International

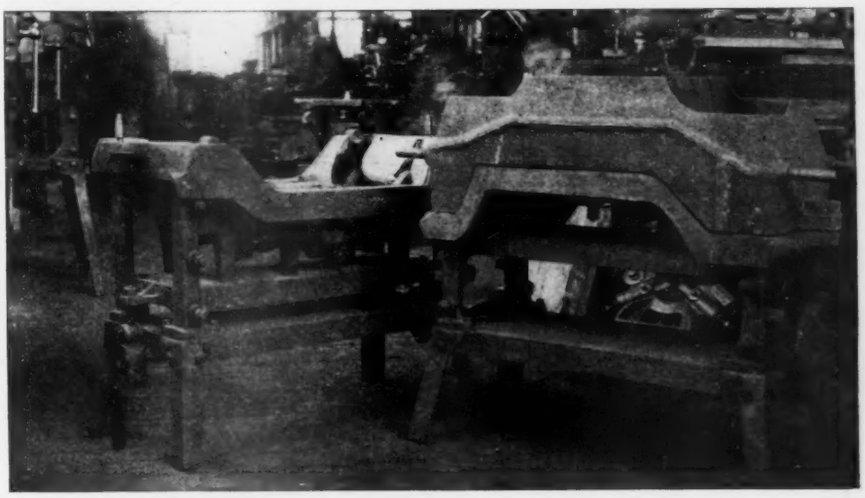
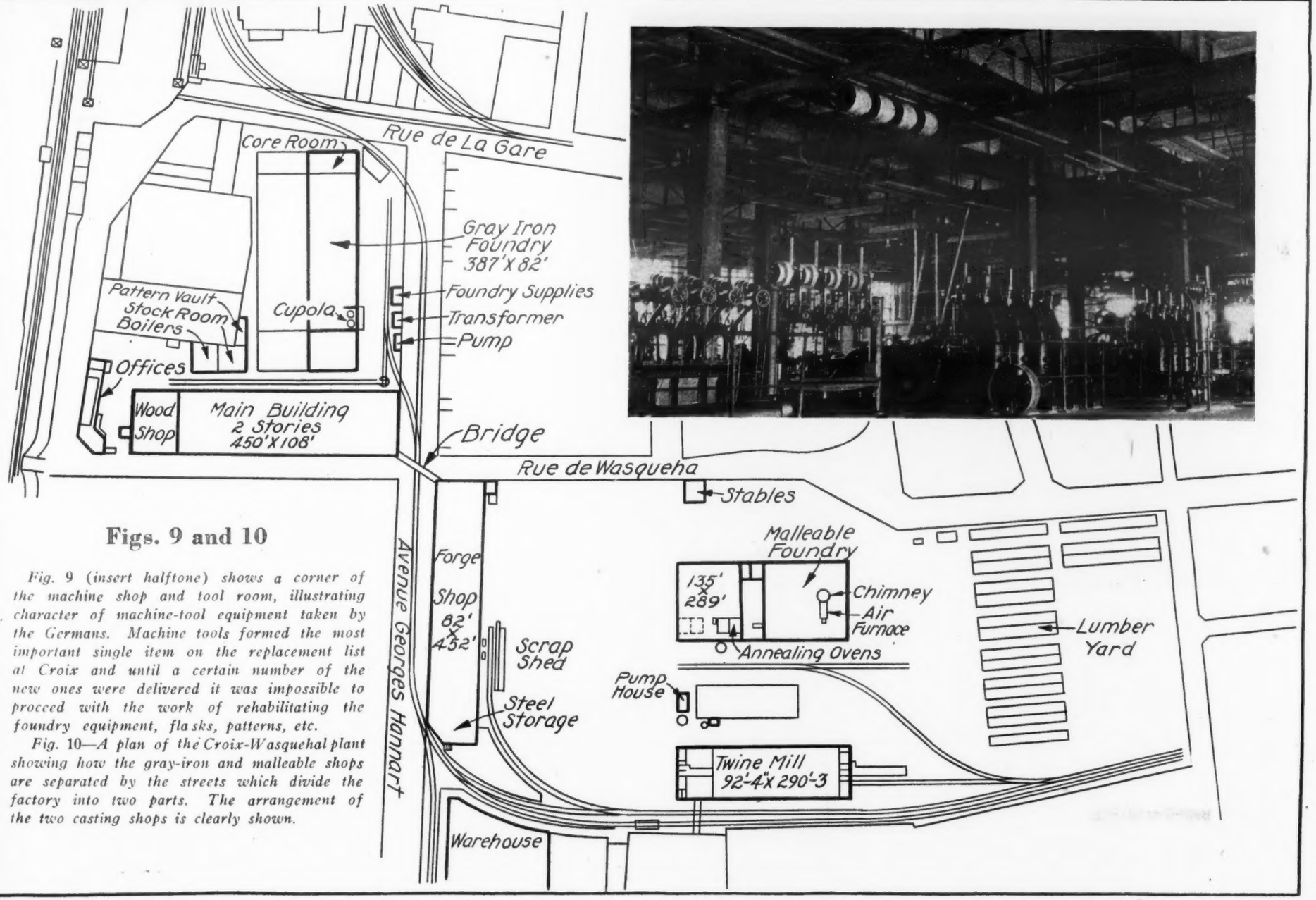


FIG. 8—A CORNER IN THE TOOL-ROOM DEVOTED TO MOLDING MACHINES, FLASKS AND PATTERNS



Figs. 9 and 10

Fig. 9 (insert halftone) shows a corner of the machine shop and tool room, illustrating character of machine-tool equipment taken by the Germans. Machine tools formed the most important single item on the replacement list at Croix and until a certain number of the new ones were delivered it was impossible to proceed with the work of rehabilitating the foundry equipment, flasks, patterns, etc.

Fig. 10—A plan of the Croix-Wasquehal plant showing how the gray-iron and malleable shops are separated by the streets which divide the factory into two parts. The arrangement of the two casting shops is clearly shown.

Harvester Co. as it was before the war —and is today.

During the war this great establishment was reduced to chaos. Its present satisfactory condition is the result of over 15 months' hard work and the expenditure of some $2,000,000. It is one of the few large "reconstructed" works in northern France. This means that in the interval since the liberation of Lille from the enemy in October, 1918, the entire plant has been completely re-equipped and renovated; a new stock of pig iron, scrap and other raw materials has been assembled, and an operating staff again gathered together. All this has been accomplished amid the chaotic conditions following the war, and in the face of serious difficulties, not the least of which was the lack of railroad facilities for bringing in new equipment and raw materials. It is not too much to say that American courage, initiative, energy, and willingness to make liberal investments to secure results, have scored another victory in Europe—on the very field of battle. In this effort the French population and government officials co-operated to the best of their ability, for the rebuilding of the Croix factory means independence and prosperity again to over a thousand families. This is a practical way to aid "starving Europe," and it involves not the giving away but the investment of Yankee dollars on a liberal scale.

No Simple Problem

While this article covers almost exclusively the technical problems encountered in rebuilding and operating the Harvester company's foundries at Croix-Wasquehal, it should be borne in mind that what was really dealt with was a far larger task. For while the plant itself was being reanimated, community life in the surrounding towns, without which no industry can exist, had to be gradually reconstituted. A people who for over four years had been ground under the heel of an absolutely ruthless invader had to be set going again. At the close of the war Lille, Turcoing, Roubaix, and Croix-Wasquehal were dead communities in which the people had been struggling for nearly half a decade against forcible deportations and other horrors for a mere existence. With the exception of water supply, even the elementary functions of municipal life had been suspended, including electric light and power, telephone service, street cars, etc. The trolley poles in fact were stripped bare of wire. But a recent visit to Lille found life moving in its accustomed grooves, with lights, music, even heat, and transportation. Much remains to be accomplished, it is true, but much has been accomplished. Those conveniences which we take for granted in the United States were totally lacking in November, 1918, while in December, 1919, normal, civilized life was in evidence on all sides. This phase of the situation is emphasized, because the extraordinary conditions under which the units of the Croix-Wasquehal harvester plant were rebuilt and set going again should constantly be kept in mind as a background against which the more or less conventional feats of engineering involved in the reconstruction operations can be thrown up in proper perspective.

Some Practical Hints

At the same time the experience of the International Harvester Co. should contain suggestions of practical value to other American manufacturers who may be contemplating the establishment of casting plants in Europe during the postwar period. Many of the difficulties and conditions encountered by the Harvester company were no different than would fall to the lot of anyone trying to convert a set of more or less dilapidated empty buildings into an operating property anywhere in western Europe.

Before taking up the reconstruction and operation of the Croix foundries in detail, their history under the German occupation should be presented.

The Croix plant was closed with the invasion of Belgium. The Germans entered in October, 1914. The removal of machinery and equipment actually began in May, 1915, and continued on an increasing scale throughout the duration of the war.

Saxon infantrymen occupied the foundry in the spring of 1916. As shown in Fig. 2, they converted it into a rolling mill for corrugating heavy trench protection sheets and other work, moving two of the heating furnaces from the forge shop for that purpose. The molding machines and other foundry devices were of course scattered about, although few appear to have been actually removed. No special large scale operations appear to have been attempted in this improvised rolling mill.

In neither of the foundries were there the bodily removals that took place in the machine shop, forge and twine mill, but this does not mean they were not seriously knocked about. Fig. 2 is evidence of the condition in which the Germans left the casting plants. In the gray-iron shop the cupolas and tumbling mills were left intact; the former probably were used. Also relatively few of the molding machines were taken, but nearly all the machines were displaced from their foundations, piled up indiscriminately and suffered severely through four years neglect. Every one had to be overhauled. This also applies to all other machinery the Germans chanced to leave behind.

The stock of pig iron, scrap and coke on hand when the plant was closed down in 1914 was either melted up or taken away. This also applies to new sand and other foundry supplies of all sorts. Finished castings were dumped outside and molding sand thrown on top of them—probably to make room for the rolling mill previously mentioned. The entire stock of flasks, metal patterns, etc., was either melted up or carried away. About 3750 cast-iron flasks have had to be replaced.

The invaders displayed less interest in the malleable foundry, but it suffered severely like the other units from four years neglect, disuse and employment as a stable.

The work of reconstruction started in December, 1918, but did not get in full swing until the spring of 1919. The task may now be said to be completed, although many details remain to be cleared up.

Preliminary Steps

Returning now to the technical details with which the staff of experts of the Harvester company was confronted in the re-establishment of its foundries on an operating basis, it was first necessary to make a complete survey of the situation as the enemy left it. This was done not only for purposes of general information, but to determine in detail what equipment was missing, what of that which remained could be repaired, and what new machinery would have to be obtained to make good the loss and damage. Replacements, taking the plant as a whole, formed by far the largest item, but in the foundries it was more a question of rehabilitating existing equipment, with the main exception of flasks, patterns and melting stock. With reference to new machinery, the engineers and executives on the spot had to decide whether it should be built at the works, as in the case of flasks and patterns; or purchased in France, as in the case of shafting, hangers, pulleys, motors, etc.; or imported from the United States, as in the case of machine tools. This procedure had to be gone through with respect to each item of equipment and supply in the whole establishment. The plant had to be refurnished from cellar to garret. This in its turn involved the repair of the buildings; the provision of power, light, heat and transportation facilities; the replacement or repair of all necessary tools and machinery; the acquirement of a new stock of raw material; and the assembly of an executive and working force.

In connection with the purchase of new equipment it was necessary in each case to decide whether it should be

FIG. 11—STRIPPING-PLATE MACHINE FITTED UP TO MOLD MOWER WHEELS

obtained locally or imported from the United States. The latter was in some cases the easier policy, but not the most intelligent. A manufacturer who goes into a foreign country with the attitude of a sponge, always soaking up more, is likely to come to grief sooner or later. The Harvester company has always proceeded on the theory that its European plants are integral parts of the countries in which they are located, and wherever possible the policy of favoring the local producer is followed, other things being equal. Good will is thus created, and when necessary the hearty co-operation of governmental authorities can be secured. This is a more important matter in Europe than it is in the United States.

Furnishing the different units of the plant once more with power constituted one of the largest single jobs connected with the reconstruction work. The foundry machinery, as previously stated, is all motor driven, and the Germans took all the motors—over 2200 horsepower in the whole plant—together with the starting devices, switches, wiring, shafts, pulleys and belts. The 150-horsepower Ingersoll-Rand motor-driven air compressor, used mainly for foundry purposes, also was removed. Both foundries were stripped of everything that had to do with the generation or transmission of power. Four of the seven main transformers also were carted away. New power equipment has been purchased throughout, mostly in France.

The overhead hand cranes in the gray-iron foundry were not disturbed. The charging-floor hoist was put out of action through the removal of the boilers, this unit being a steam-hydraulic elevator of the Ridgeway type. This hoist has been put back in service in an ingenious manner which illustrates the numerous expedients it has been necessary to devise to get the plant again on an operating basis. The delivery of the new boilers being long delayed by traffic congestion and other causes, a heavy-duty chain hoist of the triplex type was secured and belted to a 4-horsepower motor in the manner illustrated in Fig. 5, the elevator platform being suspended directly from the chain-hoist. The general exterior arrangement of this device is shown in Fig. 3. Although this improvised hoist operates slowly, it serves the purpose for the time being, and allows the cupolas to be charged.

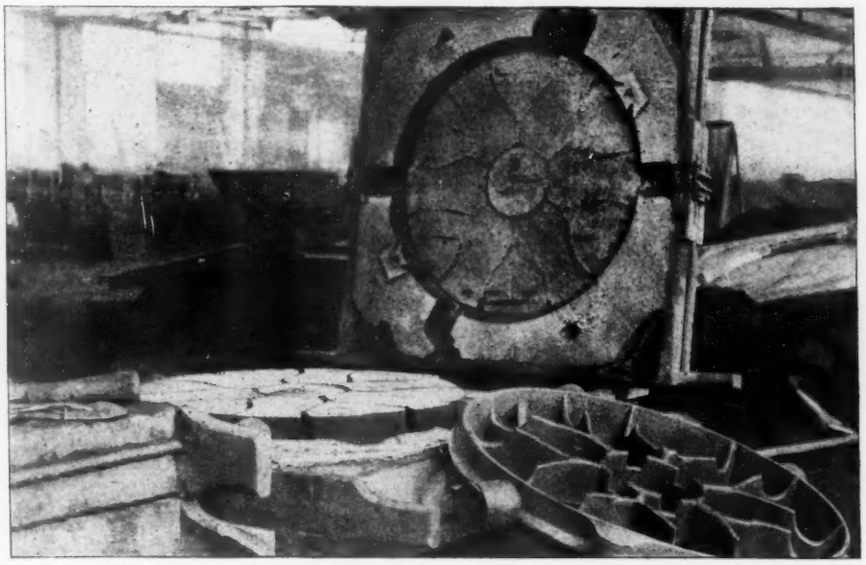


FIG. 13—HOW THE 3750 NEW FLASKS WHICH WERE REQUIRED WERE MADE

FIG. 12—DETAIL OF IMPROVED MOWER-WHEEL FLASK SHOWING CLAMPS

The gray-iron foundry building was not damaged except for the window panes which had to be renewed almost completely. In the whole plant some 3600 panes of glass were replaced. The water-piping had not been disturbed although the 60-cubic meter tank which supplies the plant was allowed to half fill with sludge.

The two cupolas are of the old Colliau type and were built by Byram & Co., Detroit. They are lined at present to an inside diameter of 40 inches and are rated at approximately 10 tons per hour. They present no special features.

The arrangements on the charging floor and at the spout are shown respectively in Figs. 4 and 6. The ladle equipment was all taken by the Germans and has had to be replaced. Fig. 6 shows the type of bull ladle now employed. It is cylindrical, with removable ends and a pouring spout on one side fitted on like a boiler saddle. It is said to be always in balance and to hold the heat unusually well.

Under normal conditions ordinary good gray-iron mixtures are melted, as in similar foundries in the United States. Half of the charge consists of good machinery scrap, including the foundry remelt. The pig iron which makes up the other half of the burden usually is mixed in the ratio of 25 per cent French hematite, or low-phosphorus, and 75 per cent French foundry iron. The hematite has approximately the following composition: Silicon, 2.0 per cent; manganese, 1.5 per cent; sulphur, 0.06 per cent; and phosphorus, 0.10 per cent. The foundry iron contains: Silicon, 2.3 per cent; manganese, 0.6 per cent; sulphur, 0.05 per cent; and phosphorus, 1.0 to 2.0 per cent. The transverse strength of the mixture is about 2660 pounds per square inch. The coke, which is used in a ratio roughly of 1 to 9, has the following composition: Volatile matter, 0.75 per cent; moisture, 1.00 per cent; sulphur, 1.13 per cent; ash, 12.92 per cent; and fixed carbon, by difference, 84.20 per cent. Its heat value runs about 7000 calories per kilogram.

The molding practice is standardized along well known American lines and presents no unusual features to those acquainted with the methods employed in the United States for molding mower frames, mower wheels, etc. These methods have been frequently discussed in THE FOUNDRY. Stripping-plate machines are employed almost exclusively for this work. Fig. 7 shows two mower-frame machines built by Henry E. Pridmore, Inc., Chicago, mounted on platform trucks for return to the foundry from the tool room where they were repaired. These machines were in the hands of the enemy for over four years. A round stripping-plate machine fitted up for molding mower wheels, with one of the new flasks, is shown in Fig. 11 ready for work again alongside the heap of new sand. This machine sits about where the Germans had their rolling mill and the transformation of the shop back to ordinary foundry conditions is evident. Another view of the new mower-wheel flasks, which are of a sturdy improved type is shown in Fig. 12. Note particularly the strong, improved flask-clamp shown in this illustration. It is made of cast iron specially to fit the flasks and is provided with a coarse quick-acting screw clamp which insures a tight hold. The method of making the mower-wheel flasks themselves is illustrated in Fig. 13. They are molded in wooden boxes on the floor in the ordinary manner, and as previously stated it was necessary to make about 3750 flasks of this and other types before the foundry could be restored to the condition shown in Fig. 14, ready for operation. This latter illus-

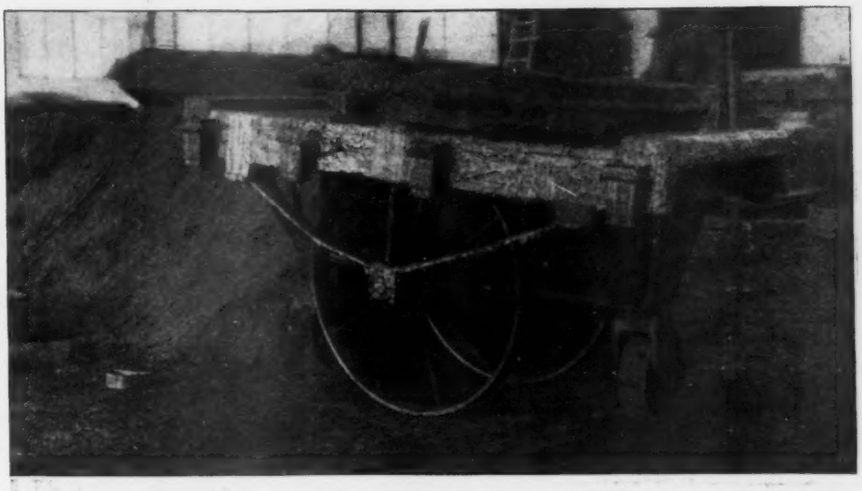


FIG. 15—AN IMPROVISED BUGGY USED FOR HANDLING FLASKS

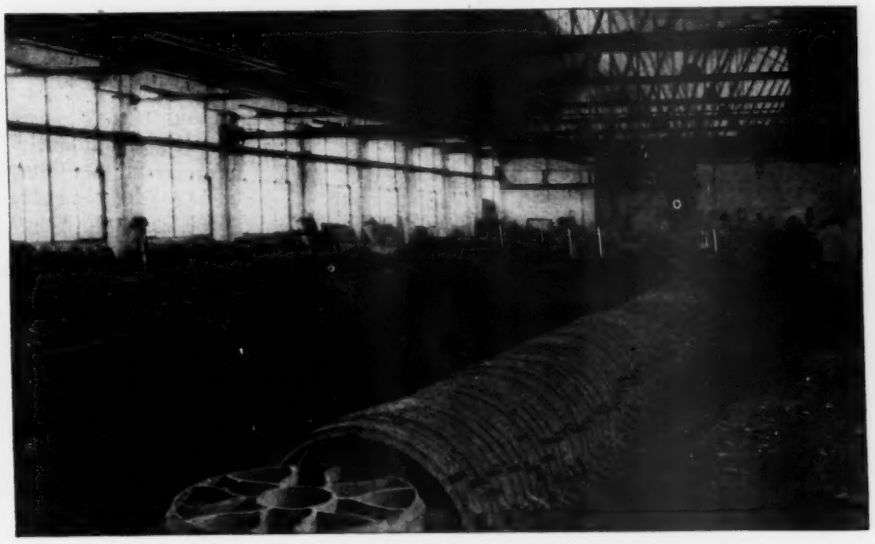


FIG. 14—A MOWER-WHEEL FLOOR ONCE MORE READY FOR BUSINESS AFTER CLEARING OUT DEBRIS LEFT BY THE GERMANS

FIG. 16—A GIRLS' CORE ROOM HAS BEEN FITTED UP FOR SMALL CORES

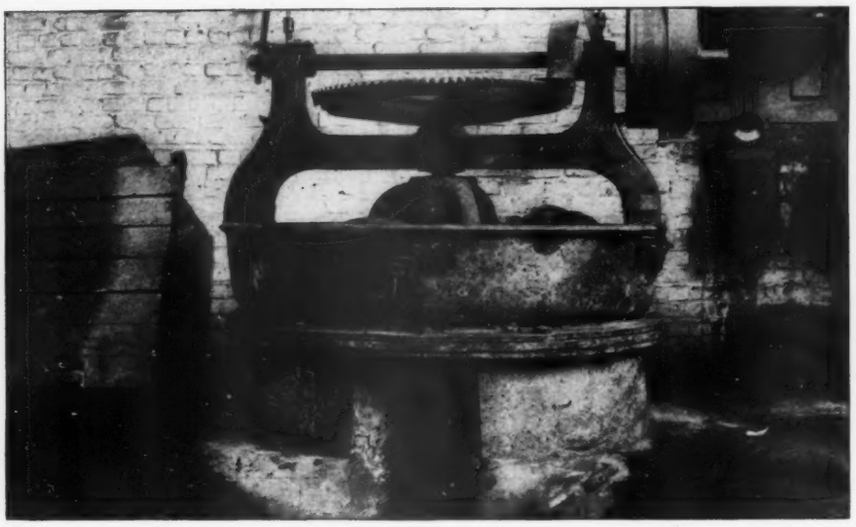


FIG. 17—SAND-MIXING MACHINE OF FRENCH CONSTRUCTION

tration shows clearly the general arrangement of the mower-wheel floors.

Another one of the expedients adopted to quickly make good the havoc wrought by the invaders is illustrated in Fig. 15, which shows how paint-shop buggies were impressed into service in the foundry to handle flasks and other materials.

Tool-Room Difficulties

Since all the flask and pattern equipment had to be renewed and refitted to the machines, the tool-room and metal pattern shop in the main building was a very important place from the standpoint of the foundry. It was necessary also to send the molding machines into this department for repairs. But the tool room was stripped clean and had to be re-equipped throughout. It was necessary to replace nearly 40 tools from engine lathes down to small grinders. The cost of this new equipment is far in advance of the original investment prior to the war.

Similar conditions were met in the wood pattern shop, where rip saws, cut-off saws, wood shapers and jointers had to be replaced.

A new girls' core room has been fitted up with modern benches, core boxes, etc. It is shown in Fig. 16. One of the few pieces of French equipment, aside from motors, shafting, etc., installed in the gray-iron foundry is shown in Fig. 17, where it remained undisturbed. It is a facing and core sand mixer of the rotary paddle type, fitted with large spherical cast-iron cages for grinding up the sand.

The general features of the malleable castings foundry have already been described. The Germans seemed to be so busy in other departments, that, relatively speaking, they left it alone. It was used for a time as a stable and has had to be completely renovated, and much of the flask equipment, pots, etc., renewed. Round cornered annealing pots are employed. They are made of white iron and are cast in large wooden flasks on the floor, as shown in Fig. 18, which illustrates one of the pots coming out of the sand. A whirling skim-gate is employed to insure clean metal.

The fate of the raw material and stock in process of manufacture at the outbreak of the war has already been sketched. All of it disappeared during the four years occupation. Therefore in addition to rebuilding and replacing the equipment, a complete new stock of sand, coke, pig iron, facings, and other foundry supplies has had to be secured. The molding sand comes from nearby and is of exceedingly good quality. French sand in fact is famous throughout the world and the finer grades are imported extensively into the United States for certain classes of work. For other materials, many new sources have had to be developed. For instance it has been necessary to go far afield for coal and coke, due to the reduction of the output of the Bassin du Nord mines near at hand from 4,800,000 tons in 1913 to 900,000 tons in 1919. Similar conditions apply to pig iron and other essential materials.

A new personnel also has had to be assembled in order to operate both the gray-iron and malleable foundries. Some of the old employes are still at hand; all that can be located are being taken back. Many unfortunately are dead and others have been so scattered by the war that it is impossible to discover them. So there are many new faces in the casting shops, and throughout the plant, now that the Croix-Wasquehal foundries are again ready for work.

Publishes Periodical on Asbestos Products

Asbestos is the title of a new monthly publication which is being issued in the interest of the asbestos and magnesia industries for the purpose of bringing about better understanding among miners, manufacturers, jobbers and consumers. The new magazine, of which the sixth monthly issue now is off the press, is published from 721 Bulletin building, Philadelphia. The current issue contains several interesting articles on asbestos and magnesia products together with some market statistics and developments.

The Dodge Steel Co., of which Kern Dodge, Morris building, Philadelphia, is president, just has completed a modern steel foundry at Tacony, Philadelphia, equipped with an electric furnace of the Greaves-Etchells type.

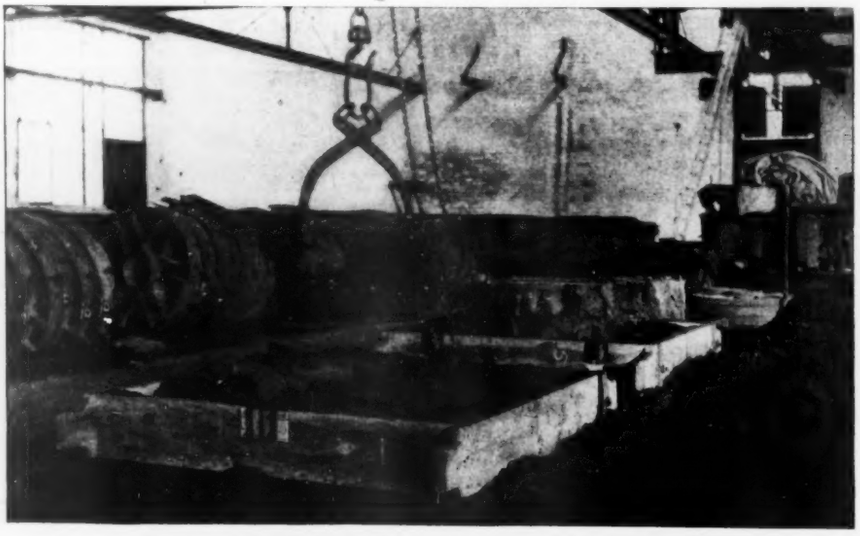


FIG. 18—SHAKING MALLEABLE ANNEALING POTS OUT OF THE SAND

Electrical Melting of Alloys—I

Fundamental Reasons Underlying the Evolution of Electric Furnaces for Melting Nonferrous Metals Are Analyzed — Theory Blazed the Trail Which Practice Followed in Design

BY H. W. GILLETT

FOUR years ago there were no electric furnaces in commercial use on brass melting, although several types extant were almost past the experimental stage and ready for industrial use. There are now in commercial operation or contracted for, something like 250 electric furnaces. The phenomenal growth of electric brass melting is made even more striking when compared with that of electric steel furnaces. The electric steel furnace in this country was started in 1906. In 1911 there were only four. In 1917 there were 155, and there are now 323 in the United States and about 1025 throughout the world. It is true that electric steel furnaces normally are considerably larger than electric brass furnaces, but the same is true of fuel-fired furnaces for the respective purposes. In fact, the average electric brass furnace has a greater capacity than the average fuel-fired brass furnace, while the average electric steel furnace has a smaller capacity than the average fuel-fired steel furnace. It is doubtful if tonnage steel ever will be made generally in the electric furnace, while tonnage brass, if it can be so termed, seems certain to be.

Since the electric steel furnace can refine cheap, low grade scrap to high quality metal, while the electric brass furnace merely melts and cannot refine, it would seem off-hand that the steel furnace had the advantage. What, then, is the reason for the amazing growth of electric brass melting, since its inception four years ago? There is one perfectly good and sufficient reason—it costs less to melt brass by electricity than by fuel. Like all general statements, this is true in the great majority of cases, and it is false in others. In those where it is true, it may cost a little less, or it may cost a great deal less. Relative economy depends upon different factors just as under varying conditions a Packard, a Ford, or a donkey each may be the cheapest method of transportation. The different electric furnaces in commercial use, and the conditions under which different types are the most economical, or under which it is best to utilize the old stand-by, the pit fire, will be discussed in later articles. The reasons why electric furnaces as a class, properly chosen for the work in hand, reduce melting costs in the general run of foundry and rolling-mill conditions will be considered here. When the theory and practice both are correct, they both agree sooner or later. One often lags behind the other, and, more often than not, it is the scientist—theorist, if you will—who is hard put to it to keep up with his practical brother. The scientist must evolve the correct theory to account for the practical success of someone who didn't know that a previous theory indicated that a certain scheme would not work, but went ahead and made it work. The electric brass furnace did not happen in this way. It was recognized 15 years ago that fundamental laws of physics and of chemistry indicated that an electric furnaces, one that could be tightly closed to keep the air out and the zinc in, should prove the ideal brass melting medium. Back in 1905, Roeber*, since dead, a shrewd electrochemist and a good American citizen though of German descent, pointed out that the electric furnace offered

An Engineer's Study of Brass Furnaces

STARTING with this issue THE FOUNDRY presents a series of articles covering the entire subject of electric furnace practice as applied to nonferrous metals. The series was prepared especially for this magazine by H. W. Gillett, chief alloy chemist of the United States bureau of mines, who is undoubtedly one of the best informed practical authorities in the world on this subject. The facts upon which the articles are based were gathered by the author during seven years connection with the bureau. However, the deductions and conclusions drawn and all opinions expressed are presented according to the individual viewpoint of the writer and in no sense are to be considered the official judgment of the bureau. Electric furnaces for melting nonferrous metals are a comparatively recent evolution, but careful study and research have brought them to a high state of perfection within a few years. Mr. Gillett analyzes the entire field of electric brass melting and gives the reader the benefit of his engineering judgment relative to the adaptability of electric units under different operating conditions. He takes up each type and points its merits and limitations. He comments upon the points of design in terms which are readily understood by the practical foundryman whose knowledge of electrical science is limited. Costs, both of installation and operation, are studied in detail and the method of arriving at the best economy is presented. Mr. Gillett suggests in a simple direct way numerous practical points on setting up, and operating the different electrical units. He presents a forecast of the future development of electrical melting furnaces, outlining improvements which are needed in the present types. This series will run continuously through succeeding issues until completed.

Published by permission of the director of the bureau of mines. This series of articles is prepared at the request of the editor of THE FOUNDRY. More complete data will be presented in a bulletin of the bureau of mines soon to be published.

*Roeber, E. F., editorial, "Manufacture of Brass in the Electric Furnace," Electrochem. & Metallurg. Ind., Vol. 3, 1905, p. 4.

larger melting units with the attending decrease in labor cost, the elimination of crucible cost, a high grade product, and the almost complete elimination of the loss of zinc. He predicted the replacement of the old crucible brass furnace by the electric furnace inside of 10 years. Had suitable electric furnaces been ready to translate theory into practice, his prediction might have been fulfilled in the period stated, but they were not. If this replacement had been brought about before the war, the saving in metal losses, crucible and labor costs during the years 1917 and 1918, according to the writer's computations, would have reduced war expenses by not less than $20,000,000. The growth of electric brass melting did not come soon enough to make this saving. However, it is making considerable savings now, and will continue to do so at an increasing rate. Practice is beginning to catch up with theory.

Metal losses in fuel-fired furnaces occur by loss of zinc and lead through volatilization, by oxidation and slagging-off of less volatile metals; and mechanically, by spilling into ashes and by fine particles being blown out or drawn up the stack. These losses occur because the products of fuel combustion must get out of the furnace. The draft, or the flow of gases, carries with it much zinc and lead. Excess air usually has to be admitted and that causes oxidation. Sulphur from the fuel may be present in the products of combustion and may be taken up by the metal. Neither the volatilization losses, the oxidation, nor the absorption of sulphur are constant, so the product varies in composition and in quality.

If we could close a furnace tightly and generate the heat inside it, we could retain the volatile metals and prevent the constant influx of the "sea of air" in which we live. This also would do away with the passage of products of combustion over the metal. Theoretically, all this could be done in the electric furnace, with the result that metal losses should be nearly eliminated and the quality of the product should correspond with that of the material charged, without detriment by oxygen or sulphur. This would produce metal of crucible quality without the use of crucibles, and that in furnaces of respectable size. The need for quality is the main reason for the use of crucibles and their fragility is the main reason for the small melting units in crucible practice.

It then should be possible to eliminate crucible cost and vastly reduce labor cost by larger scale operations. These costs also are eliminated and reduced by the open-flame oil furnace, but that does not help on yellow brass because the volume of products of combustion sweeps the zinc out. Even on red brass, it is a constant struggle to maintain quality in the open-flame furnace because of the danger of oxidation. Obviously it should require less skill to produce satisfactory metal from an electric than from an open-flame furnace. Good metallurgical results should be obtained more readily, due to the better control of temperature in the electric furnace and due to thorough mixing, and hence uniformity, of the charge. Again, electric heat is clean heat. It is generated within the furnace, and there is no out-rush of heat comparable to that of the gases of fuel combustion. Hence, the vicinity of an electric furnace should be cooler and should make for the comfort and efficiency of the workers.

Since the zinc is retained in the furnace, the danger of *brass shakes* should be reduced. Since pulling pots full of metal from pit fires is dispensed with, many bad burns should be prevented. Electric furnaces therefore should tend to create healthy, efficient and contented, furnace tenders. Moreover, the requirements as to muscular physique should not be as high as for tending pit fires, and the operation of the furnace to produce good metallurgical results, should be more nearly fool-proof than with pit fires, especially the open-flame furnaces. Muscle and experience being less necessary, and workers with brains being more likely to be attracted to the furnace tender's occupation on a relatively clean, cool furnace, the superintendent should be able to choose his furnace tenders from a larger number of applicants when the electric furnaces are used. These advantages all have value, and if they can be obtained cheaply enough, in an electric furnace that is reliable enough to stand up to its work day after day and month after month, the wide-awake brass melter desires to obtain them.

It was long after the theory was clear before electric furnace designers had suitable, reliable furnaces ready for operation on brass. They had to leave the previously worked out types of electric steel furnaces and strike out in other, and in some cases, unblazed trails. When they did produce suitable furnaces, they were necessarily expensive to build. Where fuel-fired furnaces are priced in hun-

H. W. Gillett—The Man

IT HAS been said that to know a man you must be familiar with his avocations as well as his vocation, and that no true estimate of his worth may be formed when only his business or industrial pursuit is known. The author of this series was asked for some details regarding his career and a photograph to accompany a short biographical sketch in this issue. His reply which is quoted verbatim offers a glimps of the writer's personality.

.....I will endeavor to make the articles popular, and will write them from the brass furnace rather than the electric brass furnace point of view.

As to the photographs, I haven't had a real one taken for many years. Anyhow, I would prefer the use of the enclosed if it will reproduce.

The "career" is as follows: Specialized on electric furnaces in graduate work at Cornell; general chemical work in the laboratories of Thomas A. Edison and A. D. Little; started the research department of the Aluminum Castings Co., thereby gaining some idea of brass, bronze, and aluminum; for the past seven years have been on bureau of mines work with nonferrous alloys, the main problem being electric brass melting; and, during the war, various war problems of the bureau dealing with electric furnaces.

I expect to be an expert in three fields before I die:

1. *Electric brass furnaces.*
2. *Repairing toys as fast as three youngsters can smash them.*
3. *Extraction of all varieties of fish—bullheads to brook trout —from their lairs.*

and am dividing my time among apprenticeships in these three fields.

I am one of the numerous vice presidents of the American Electrochemical society, and guess that is all.

Please do not refer to me as "Dr." Gillett. I possess and detest the title, as it has too much of a Tuctonic flavor.

Sincerely,
H. W. GILLETT.

dreds of dollars, electric furnaces are priced in thousands.

However, if an American manufacturer can be shown that he will make an ultimate saving, he does not hesitate to make an initial investment. He has to be shown a little more fully that a large investment will save money in the end, than if the original investment is small, but when he is convinced he invests freely. Therefore, high first cost is only an apparent obstacle.

Power vs. Fuel Cost

A British thermal unit from electric power costs much more than a British thermal unit as fuel.. A kilowatt hour, the unit on which most electric energy for electric furnace use is bought, is equivalent to 3412 British thermal units. A pound of Connellsville coke averages 12,500 British thermal units, equivalent to 3.7 kilowatt hours. At 1 1-3 cents per kilowatt hour, about the average cost for brass furnace power, it costs 5 cents for the amount of electric energy contained (in its thermal equivalent) in 1 pound of coke.

If coke furnaces were as efficient as electric furnaces, this would mean that power at 1 1-3 cents per kilowatt hour and coke at $112 per ton would be equivalent in heating power per unit cost. However, if a coke furnace utilizes 6½ per cent of the theoretical amount of heat in the coke, it is well operated, while, even on eight to 10-hour operation, several electric furnaces will utilize 50 per cent of the heat supplied as electric power, and one or two furnaces, on 24 hour operation, will utilize as high as 80 per cent.

Considering the greater thermal efficiency of the electric furnace, the cost of heat at 1 1-3 cents per kilowatt hour is equivalent to coke at $14.50 a ton in an electric furnace operating at 50 per cent efficiency; and at $9 per ton, in one operating at 80 per cent. Comparing these figures with actual prices for coke, it is easy to see that, while electric energy is still a more expensive means of heating than fuel, yet the margin between cost of power and cost of fuel is not so great. The other savings, in metal loss, crucible cost, or in labor, readily may swing the balance in favor of electric melting.

From the viewpoint of fuel conservation, it is worth noting that, with a moderately efficient electric furnace, one can burn a certain number of British thermal units as bituminous coal under the boiler of a steam-generated, electric power plant, turn it into electricity, transmit the electricity to the foundry, turn it into heat in the electric furnace, and then melt more brass with that heat than he can with the same number of British thermal units as coke, oil or anthracite, used directly in a fuel-fired brass furnace. Where it is available, water power can be used to generate the electric power. Moreover, prices of coal, coke, and oil, unless a long-time contract can be secured, may vary considerably from month to month and lately a general trend upward is noted. A rise in cost of fuel may take place after a price has been quoted for castings and thus cut into the profits. Electric central station companies are public utilities, and their rates are regulated. Therefore, melting costs may be predicted with accuracy for longer periods than when fuel is used.

The trend of electric power prices has been steadily downward, owing to the steady improvements in power plant operation. Power prices are now stationary or slightly rising, due to cost of coal, but nowhere in proportion to the cost of coal. Power prices may be expected to remain stable and reasonable, with an ultimate reduction when the utilization of water power and the tying-in of isolated power plants into larger networks are carried further, as they inevitably must be in the future.

Whatever its source, electric power comes to the foundry over wires and through a meter and transformer, which is a clean and compact way to receive fuel compared with the tracks and oil tanks or coke bins and ash piles of the coke or oil-using foundry. The labor of unloading and carting coke and ash, as well as the need to treat the ash for its content of spilled metal, the pumps and piping for oil, all are obviated.

It must be conceded that the electric brass furnace has many advantages and few disadvantages theoretically. The question is, how does it work out in practice?

The increasing use of electric brass furnaces shows that many, if not nearly all, of the theoretical advantages are present in practice. Not every type of furnace has them all to a complete degree. Most types have most of them in fair degree. Some excell on one point, some on another, so that to obtain all the theoretical advantages, or the maximum possible utility, the furnace must be chosen for the particular work in hand.

Assuming that a reasonably intelligent choice has been made and the particular electric furnace chosen has not been assigned work for which it is not fitted, we find that the following advantages have been found in commercial practice.

Metal losses have been greatly reduced. Plant after plant is regularly melting not only red, but yellow brass as well with less than 1 per cent net metal loss and doing it on charges that would give truly excessive losses in fuel-fired furnaces. In addition to avoiding all working over of ash for contained metal, the electric furnaces produce less slag and dross, and more metal in the ladle. Where a crucible or an open-flame furnace might give 94 per cent ready to pour, 4 per cent in slag, dross and ashes, requiring recovery, and 2 per cent net loss, electric furnaces are producing 98½ per cent ready to pour, ½ per cent to be recovered from slag and 1 per cent net loss. Not only is there 4½ per cent more metal ready to pour without another melt, but 3½ per cent remains to recover, and to lose value, due to its change in composition and adhering impurities, and 1 per cent net or more is saved.

Crucibles have, of course, been eliminated, save where they are used as ladles.

Labor costs have decreased materially where enough electric furnaces are in use to permit this, although during the period in which a plant is getting acquainted with its first furnace, it generally just about breaks even.

Human Conservation

Working conditions are truly improved. The only brass rolling mill which so far has gone completely over to electric melting states that since the change it has not had a single case of *brass shakes*, and the serious burns are greatly reduced. As to coolness and convenience, all that is necessary is to watch a few furnaces in operation —an item of cost most superintendents will be glad to accept. When furnace tenders on fuel-fired furnaces quit work in summer, and the furnaces had to be shut down, electric furnaces in the same plant kept on operating, and the tenders of the fuel-fired furnaces desired to be transferred to the electrics.

Experience has proved that a furnace tender does not need to be an electrical engineer to make his furnace operate satisfactorily, even though it may appear complicated at first sight. Various different types of electric brass furnaces have been operated satisfactorily by negro

crews. This does not mean that brains and their use in controlling the operation of electric furnaces, are not desirable. They are, and since the first cost of an electric furnace is high, it pays to secure brains to plan the work and to keep them going at a high rate of production. However, the actual furnace operator needs only a decent degree of common sense and intelligent supervision. Many foundrymen thought it would be necessary to use men of master-mechanic grade for furnace tenders, but this has not been found essential. Indeed, it is easier to train a green man to handle an electric installation to get good results than to handle any fuel-fired furnace.

Quality Paramount

As to the quality of the product, plant after plant making sand castings reports that the metal is no better and no worse than good crucible metal, though possibly of a little more uniform quality. The writer knows of only one plant where the quality was not considered as good as that from crucibles, and that was a case where a new type of furnace was being tried on which various difficulties with the furnace itself were encountered. Few electric furnaces, of well-seasoned commercial types, have been thrown out, and these few failures usually have been due to the choice of the wrong type for the work to be done.

Some furnacemakers claim slightly improved physical properties for electric brass over other brass, but no one seems to have cut down the thickness of his patterns in order to utilize the extra strength claimed. Proof should be available later on the physical properties of the best obtainable electric brass against the best obtainable crucible brass. Until this is worked out by long tests in a number of plants, it seems like painting the lily to claim a quality superior to the best crucible product. If it is as good as the crucible it is good enough for most any one.

At any rate, the time has passed when even the most fervid electric furnace designer or salesman is likely to spring a line of talk—as one furnacemaker did on the writer in the early days—to the effect that the "electric vibrations in the furnace cause the molecules of brass to rearrange themselves in a different order so that electric brass is stronger and denser than other brass."

Such ideas are pure "bull." The electric furnace has no occult power. It does not perform metallurgical miracles. Neither does it transmute oil, molding sand or second-hand chewing tobacco into good metal. It is a means of producing heat. If one could find a brick that would hold enough heat, heat it up, drop it, and a charge of brass, into a crucible, cover up the crucible and let the heat in the brick melt the metal, he would melt the metal much as the electric furnace does, and with just as much "mysterious improvement" in the quality.

In rolling mill practice there is probably a real improvement in the product, not in the sense that no brass as good has been made in crucibles, but in uniformity of product. The types of furnaces best adapted to rolling-mill use automatically mix and stir the metal so that all the castings from a given heat are uniform. Moreover, the decrease in zinc losses due to electric melting makes for less variation between heats, and melting in larger quantities also tends to smooth out variations due to variations in the composition of scrap fed back. Therefore, rolling mills can work to closer specifications and can make a more uniform product with the electric furnace.

As to over-all melting costs, the best proof is that hard-headed managers and superintendents are increasing their electric furnace capacity. No one can say off-hand that electric melting will save $5 a ton or $10 a ton, and have his statement necessarily true for any particular foundry. One can make an approximation as to possible savings in the industry as a whole and hit the right order of magnitude at least; but as long as different plants have different conditions, whether any electric furnace will cut melting costs, and if so, what furnace will cut them deepest, is a question only to be answered in the light of specific conditions. Knowing his own conditions, and knowing the general performance of the various types of furnaces, on which data will be presented in later articles of the series, the manager can first cast out the types that will not meet his conditions. He then can get down to brass tacks in the consideration of what the remaining furnaces have done under commercial conditions similar to his own. From this basis he will be able to make a definite decision either to install no electric furnace, to adopt some particular electric furnace, or to test out single furnaces of two or three types or makes under his own conditions, in order to get the information he needs upon which to base his judgment.

Speaking generally, it is proved commercially that electric brass furnaces, properly chosen, and properly operated, are money-savers in a great variety of plants. It is reasonable to suppose that they will prove so in many more plants.

Foundry is Merged

The Taylor & Boggis Foundry Co., one of the leading castings manufacturers in the Cleveland district, has been absorbed in the merging of five large companies at Cleveland into the Consolidated Iron-Steel Mfg. Co. The new company, which was incorporated last fall, has a capital and surplus in excess of $3,000,000. The companies involved in the consolidation are: Taylor & Boggis Foundry Co.; the Republic Structural Iron Works Co.; the Columbian Hardware Co. the Ideal Hanger Co. and the Duplex Hanger Co. The new owner will take over the various plants immediately, and it is understood the various production programs of the plants will be enlarged. Officers of the new company are: President, I. T. Kahn; vice president, H. F. Seymour; secretary, J. Lehman, and treasurer, Adolph Tuteur. These men with Corliss Sullivan, Joseph Hostetler, Richard Cobb and A. V. Cannon, compose the board of directors.

Will Build Plants

The New Jersey Zinc Co., one of the oldest and largest zinc companies in America, was organized in 1848. Its ore properties are located in various parts of the country, and include the Franklin, N. J., mine from which a high quality ore is secured. The company now is operating zinc oxide, lithophone and slab zinc plants in Pennsylvania, Virginia, Illinois, Wisconsin, Kansas and Oklahoma, and contemplates the erection of additional plants at strategic geographical points. Construction work will be commenced immediately on plants in Colorado and Pennsylvania.

The G. & R. Foundry & Machinery Co., Terre Haute, has purchased the plant of the Crawford & McCrimmon Co., Brazil, Ind. This gives the parent company additional gray iron casting capacity which is fitted to handle work up to 10 tons, and also affords additional brass and bronze casting facilities. The officers of the G. & R. Foundry & Machinery Co. are Sam T. Greenberg, president; Frank H. Reynolds, vice president; Charles Haze, secretary, and H. Stevenson, treasurer.

Methods for Molding Smoke Stacks

The Rigging Provided for Green Sand Cores Prevents Them from Bending and Permits the Production of Much Thinner Castings Than Is Possible When Using Dry Sand Cores

BY H. N. TUTTLE

SMOKE stacks such as are commonly used on steam tractors, portable sawmills, etc., are usually made of cast iron, of round section, the lower end curved and flanged to fit the boiler, while the upper end generally has some style of bead on the outside with a grooved seat and locking lugs for holding a spark arrester screen. Fig. 1 shows a typical stack of this kind. The ordinary way of molding this casting would be from a split pattern, with a dry sand core, made in a half box and pasted, but in foundries where a great many of these stacks are made, some method of making the core in green sand has generally been developed. This is not only to eliminate the cost of cores and fitting the same, but also to relieve the usually congested condition of the core room. The rigging employed in some of these methods is shown in the accompanying illustrations. Fig. 2 shows a cross section of the stack illustrated in Fig. 1, where the green sand core is *struck up* by turning as in a lathe. The arbor upon which the green sand is *struck* is made of cast iron staves, bolted onto three cast iron heads. An end view of one of these staves is shown at *A*. It is made in the form of two ribs or "fins" about ¾-inch high by ¼-inch thick, with slotted perforations between the ribs, to facilitate the escape of gas into the center of the arbor. The cast iron heads to which the staves are bolted are shown at *B*, *C* and *D*. The gas pipe center *E* serves as a spindle upon which the heads are strung for convenience in building, as well as for strengthening the arbor. The ring, *H*, with fins on the outside similar to the arbor is slipped over the small end of the arbor, and wedged in place. This is to permit the *striking up* of an enlarged diameter at the base of the stack. Of course, if the arbor were made in one piece, of this shape, it would be impossible to remove it from the casting. A dry sand ring core, *G*, makes the seat for the spark arrester screen, with its locking lugs. Another dry sand core, *F*, cores out the undercut where the base of the stack fits the boiler, and also makes the oval shape of the base. In making this green sand core, the arbor is set in a sand bin, the heads *B* and *D* fitting into corresponding seats provided for that purpose. These heads are turned in the machine shop, to make them perfectly cylindrical. The sand is packed over and between the fins of the arbor by hand, the molder turning the arbor as he proceeds with the ramming. After the arbor

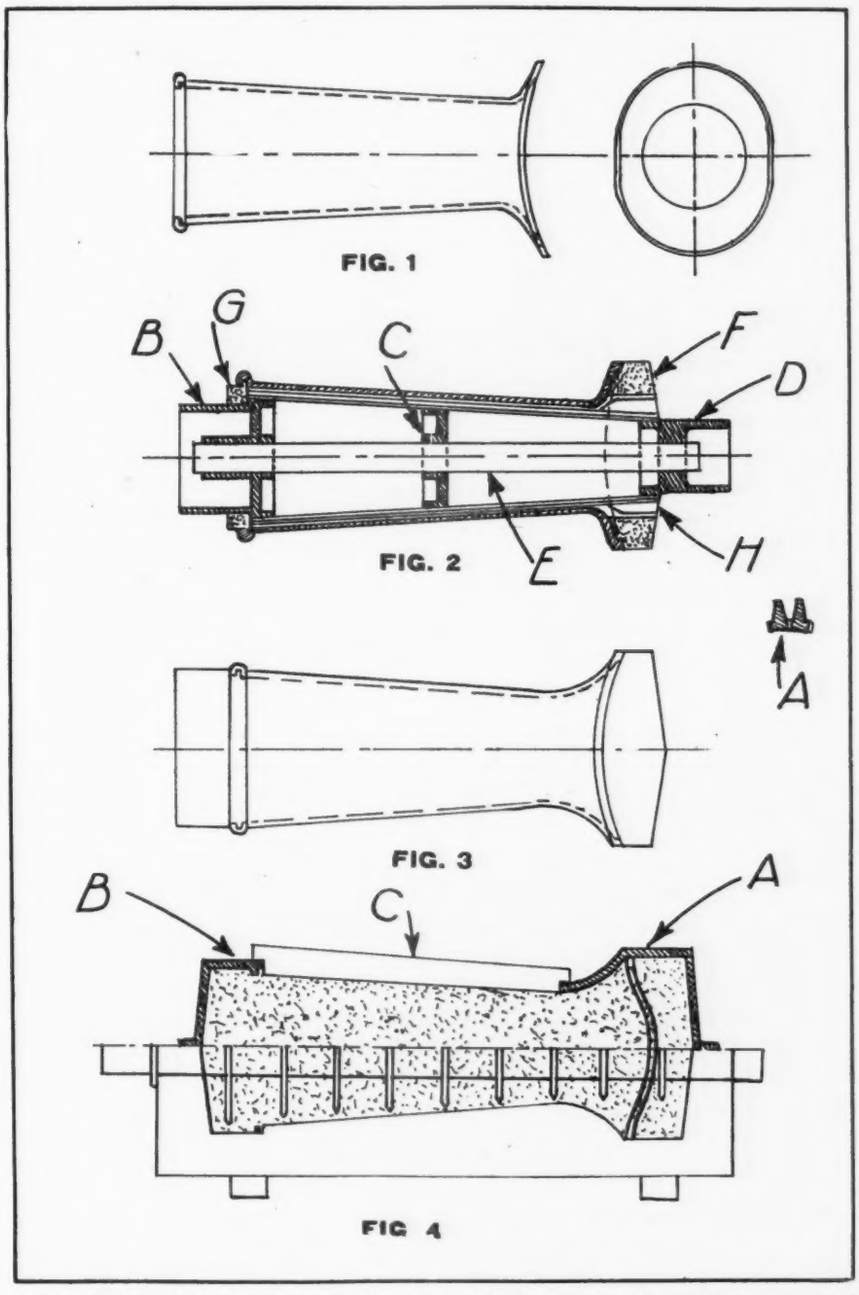


FIG. 1—SIDE AND END VIEW OF TYPICAL SMOKE STACK FIG. 2—LONGITUDINAL SECTION OF CASTING WITH CORE IN PLACE FIG. 3—SLIGHTLY DIFFERENT STYLE OF SMOKE STACK FIG. 4—THIS CORE IS MADE IN A HALF COREBOX, THE TOP OF THE ENDS FORMED IN SHELLS AND THE CENTER TOP SURFACE STRUCK OUT

is completely rammed or packed, the molder sets the "strike" against the correctly located stops, and slowly turns the arbor one revolution. This cuts the core to exact size. After setting the dry sand cores, *F* and *G*, the green sand is slicked and faced with plumbago. The green sand core is now ready to be set into the mold. The arbor projects through the ends of the flask, and as the holes in the flask ends, the prints on the pattern, and the arbor heads, have all been made to exactly the same size, it is impossible for the core to shift. Also on account of the stiffness of the arbor, the has *V*-notches cut in the ends for bearings to support the ends of a cast iron arbor. Fig. 5 shows an end view of this arbor, a half square cast shaft with wing bars cast on, about 5 inches apart. The last two bars on the base end of the arbor are left small enough to permit removal of the arbor from the casting. Special gaggers are used to help support the sand in the enlarged base end of the core. These last two bars might be made to desired size, slipped over the arbor loosely, and held in place by wooden wedges. After the lower half of the core is rammed, loose made standing in a vertical position, the center being rammed in green sand and left standing in the drag, while the outside is coped off. Any bead at the top in this case is usually made with a ram up core.

Fig. 6 shows diagrammatically a method of making a green sand core in a whole corebox similar to dry sand coreroom practice. The arbor *A*, similar to the arbor used in Fig. 4, is rammed in one half corebox. This will be the drag half of the core. It is essential that the arbor be located exactly in the corebox, as shown by the previous

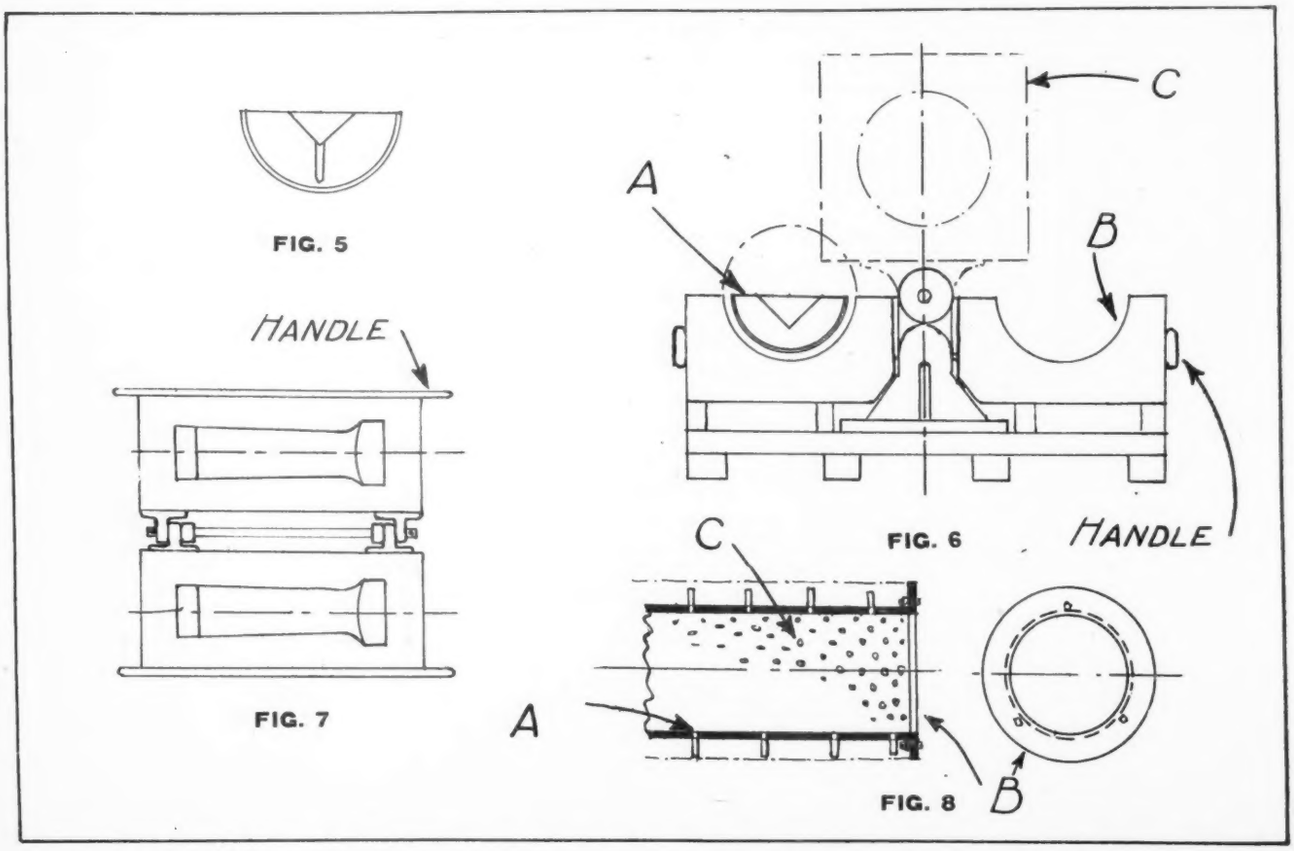


FIG. 5—ONE OF THE ARBOR WINGS FIG. 6—END VIEW OF TWO PART COREBOX FIG. 7—SHOWING DETAIL OF HINGES FIG. 8—SECTION AND END OF A CORE BARREL PROVIDED WITH WOODEN PEGS TO CARRY THE SAND

core cannot raise or buckle in the center. For these reasons it is possible to produce castings with a thinner metal section than with dry sand cores.

Fig. 3 shows a stack similar to Fig. 1, except that the oval base slopes more gradually into the round part of the stack. In this case a much larger dry sand core on the base end would be required, while a correspondingly smaller part of turned green sand core could be used, if made by the method shown in Fig. 2.

Fig. 4 shows another method of making this in green sand, better adapted to this shape of stack. The lower half of the core is made in a half corebox, similar to a corebox to be used for dry sand, with the exception that it cast iron shells, *A* and *B*, Fig. 4, are placed on the corebox, being located by dowell pins. These shells are tucked by hand through the open center ends. The center part is then rammed and struck off with the strickle *C*. If the upper end is of such delicate shape that it cannot be made to stand up in green sand, dry sand *ram up* cores may be placed in the corebox before ramming. After the core is made, it is lifted by means of the *V*-ends, which are set in corresponding notches in the ends of the flask.

In case the stack is a short one, the whole upper half of the corebox may be made in the form of a shell, the upper half of the core being rammed through the open ends. Short stacks are often method. The other half core *B*, is rammed without an arbor. After both halves have been rammed and struck off even with the parting, the two half boxes are swung up to position *C*, then swung back together until *A* is in its original position. *B* is then thrown back, to its original positon, and the core is ready to be lifted out of *A* and into the mold. Fig. 7 shows a plan of the hinges for this complete corebox.

One of the advantages of a green sand core is that it does not settle, as a baked-sand core does. How this feature is sometimes utilized to get a perfectly round core of large dimensions, say three or four feet in diameter, is shown in Fig. 8. *A* is a cast sleeve, about 5 inches smaller than the outside

diameter of the required core. *B* is a flange, turned outside to the exact size of the desired core. *C* shows the half inch holes which are spaced about 3 inches apart over the entire surface of the sleeve. Before ramming the core, wooden pegs are driven into every other hole to help support the sand. The other holes are for vents. A flange *B* is bolted on either end of the sleeve, and the intervening space rammed with green sand. It is then struck on the outside with a straight edge. The arbor may be rolled along a special wood track while the core is being molded, to protect the sand from the floor. Or, a spider may be cast in the flanges, and a large shaft put through the center, which will act as a support. In any kind of green sand core work, good equipment is essential.

Six Propeller Blades Made in One Mold

BY J. L. SENDNER

AT THE Puget Sound navy yard and at some of the Seattle foundries, it has been the custom for some time when making propeller blades and wheels to employ only one mold for an entire order. Several months ago one mold served to cast six 2-ton blades and recently four 5600-pound blades were cast in a similar manner. The mold used for this last job as well as the fourth casting made in it are shown in the accompanying illustration.

The flask is the ordinary cast-iron, built-up type, sides and ends having been cast separately and afterward bolted together. The drag is provided with bars as well as the cope for the reason that the casting is poured in a vertical position. The bars also aid materially in assisting the mold to retain its shape and rigidity while several castings are being made in it.

The blade is molded in a horizontal position but after the mold has been dried, cored and closed it is turned up on end and cast in that position with the hub uppermost. The sand used for facing is a western product similar to Albany sand. When used for the purpose under consideration it is bonded with molasses water. After the mold is finished it is surface-nailed closely in ordinary dry sand practice. It is then placed in the oven and baked thoroughly. The sections are assembled and the mold is poured.

The casting is removed shortly after the mold is poured. The latter is allowed to cool and it is then sprayed with molasses water and patched, if necessary. A thin coating of plumbago wash is then applied and the mold placed in the oven to remain over night. The following day it is taken out, assembled and cast and the same program repeated as has been outlined.

Differs From Common Practice

It is common practice where the blades are made in loam to use the molds more than once but usually the only part saved is the brick work. A new coating of loam has to be swept on, finished and dried for each casting. The method herein described and illustrated does away with the bulky and expensive loam work and is quite economical when compared to the usual dry sand practice of providing an entire new mold for every casting. The largest castings made from the type mold here shown were two 3½-ton, 4-blade solid wheels. The largest number of blades cast off one mold has been six, but the mold as shown in the accompanying illustration could be used, in the writer's opinion, for at least 10 additional castings.

Acquires Plant of Arcade Malleable Iron Co.

The Baldwin Chain & Mfg. Co., Worcester, Mass., has acquired the Arcade Malleable Iron Co., which has been doing business in that city for 70 years. Alonzo G. Davis, president and general manager, who has conducted the business since the death of Paul B. Buckingham, son of George B. Buckingham, a former owner, about two years ago, retires with the change in ownership. The company has reorganized with the same officers as that of the Baldwin Chain & Mfg. Co., George T. Dewey being president and William H. Gates, treasurer. J. Denison Kenyon is general manager.

Williams, White & Co., Moline, Ill., have purchased steel for the erection of a new foundry building, 325 x 150 feet, with a covered material yard. The Clement A. Hardy Co., Chicago, is acting as engineer.

DRY SAND MOLD FOR PROPELLER BLADE AND FOURTH CASTING MADE FROM THIS MOLD—THE CASTING IS MANGANESE BRONZE POURED FROM TWO RUNNERS AND HAS TWO LARGE RISERS FOR FEEDERS

Investigation of Silicon Reviewed

Investigations Forty Years Ago Were Handicapped by a Limited Knowledge of Analytical Methods, but Professor Turner's Work Gave a Clear Indication of the Effects of Silicon on Cast Iron

REMINISCENCES of the pioneer work done 37 years ago in studying the effect of silicon in cast iron was given by Prof. T. Turner, Birmingham university, in an address before the Coventry branch of the Institution of British Foundrymen, recently. The speaker called attention to the fact that all cast iron contains carbon, silicon, sulphur, phosphorus and manganese. He said that manganese is a metal and that sometimes other metals are present in cast iron. Small quantities of chromium and of nickel, or of copper, might be added to cast iron to give a denser structure. However, excluding manganese and other metals, the four elements which are always present in larger or smaller quantities are all specifically lighter than iron. The result is that bulk for bulk cast iron weighs less than pure iron, and the larger the proportion of non-metals present the lighter, or the less dense, would be the cast iron.

Professor Turner said that all foundrymen are familiar with the properties of carbon in various forms such as coke, charcoal, or graphite. Most of them also know the properties of sulphur; at all events they know it as brimstone, a yellow substance which burns readily in the air with a pungent and somewhat disagreeable odor. Phosphorus is generally known because it is used when mixed with various substances for making matches and other products, but foundrymen often wonder what kind of material is silicon, and why so much is said about it. It was pointed out that silicon in its pure form is not unlike graphitic carbon, except that it will not blacken the hands in the same way as plumbago will when rubbed between the fingers. Silicon is one of the most common elements found in nature, but it occurs in combination with oxygen, forming SiO_2, a common form of which is sand. This oxide of silicon is known as silica. It frequently occurs in iron ore, and the result of heating the iron oxide and the sand in the ore together with coke, is that the iron oxide and part of the silica are reduced to metallic iron and silicon. This silicon is dissolved in the iron to form a silicide of iron.

Ambition's Incentive

TURNER is a name which stands out among the pioneer investigators of the metallurgical character of cast iron. Students of cast iron metallurgy appreciate the value of Professor Turner's work to the foundry industry. Therefore, his reminiscences and conclusions given in this article are interesting to all foundrymen. When it is realized how much work has been carried on in the investigation of the effects of silicon in cast iron, it may be asked whether the same amount of investigation carried on to determine the effect of the other well known elements, which are always found in cast-iron, would not bring proportionately as much benefit to the industry. Probably not, because enough has been found out about the effect of these elements to indicate that their general influence is not as pronounced as is that of silicon. However, many facts might be learned from a searching investigation of the effect of the different gases on the properties of cast iron if experiments were carried on as thoroughly as were the experiments with silicon. The fact that accurate determination of gases and detection of the state of their existence in iron is a difficult analytical operation should not hinder, because this obstacle is no greater than those ahead of Professor Turner when he started his investigations. His work is an inspiration to younger metallurgists ambitions for research.

Accurate knowledge of the composition of cast iron dated from about 60 years ago. Professor Turner said that the earlier analyses of cast iron were often entirely erroneous; for instance, large quantities of calcium and of aluminum were sometimes reported being present, and the quantity of sulphur or even of phosphorus was not correctly given. The first step then, was to apply chemistry in such a way that all quantities of these foreign elements could be accurately determined. In England Dr. Percy, who had been called the father of English metallurgy, and who was professor of metallurgy in the Royal School of Mines had most to do with developing the analysis of cast iron.

Immediately after the Crimean war, during which time cast iron cannons were used, it became necessary to obtain a stronger material for guns than had hitherto been employed. Therefore attention was devoted to the improvement of the quality of cast iron, while side by side with these efforts Bessemer was introducing his marvellous mild steel. Professor Turner said that it was not possible then to determine, by analysis, whether a cast iron was good, bad or indifferent for any particular purpose. Because there are many variables which control cast iron and these were not understood. It is not a pure material, it is not a chemical compound, but it is a heterrogeneous mixture of various elements, compounds and solutions, all united together. If one constituent of the metal was varied, and the others also changed to some extent, it was impossible to know whether the results secured were due to one element or to the action of several elements.

Under these circumstances Robert Austen in one of his lectures, when the speaker was a senior student under him, urged that someone should ascertain the influence of silicon on iron and steel. With this object Professor Turner started experiments about 1883. The essential idea of the research was to start with the purest material that could be obtained and add to it the element whose effect on the iron it was desired to observe. The element silicon was selected for the first series of experiments. The metal used as the basis for the experiments was made by melting wrought iron in a crucible packed with the purest charcoal obtainable. The iron was melted and well stirred, then poured out. The resulting iron was white. A great many samples of this kind were made and the best of them were broken and mixed together for a further melt so as to get a uniform quality. The material was as nearly as possible a pure commercial mate-

rial composed of carbon and iron. At that time the only silicon iron obtainable contained 10 per cent silicon, and it also had more than 1 per cent manganese. Considerable time was spent in trying to get rid of the manganese, but it was found impossible to do this without also removing the silicon. To the first test bar no silicon was added, and the subsequent proportions of silicon in the metal sought were 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 7.5, and 10 per cent respectively.

Professor Kennedy, who was at that time professor of civil engineering in University College, London, advised as to the shape of the test piece and the method of making mechanical tests. The lecturer exhibited the original pattern from which the bars were cast. These bars were about 1-inch in diameter and 12 inches in the clear. They were designed so that a straight pull would be secured when they were placed in the testing machine. The results of the tests made, are shown in Fig. 1. It shows that the crushing strength increased as the silicon was increased up to slightly less than 1 per cent and then with further silicon additions the crushing strength gradually fell off.

The tensile strength increased and reached its maximum with about 1.8 per cent of silicon, and then, with more silicon added, the metal lost its high tensile properties and gradually became a weak and brittle material. The pure cast iron was hard although it could be cut with a tool. With 2 per cent silicon in the iron the carbon is chiefly in the free state and the iron is gray. This composition corresponds with 35,500 pounds per square inch, which at that time was the record tensile strength for British cast iron. To illustrate how science has progressed in the interval, the speaker said that firms will guarantee their iron to have a tensile strength as high as 38,000 pounds per square inch and will maintain that for a period. It is not uncommon now to have cast iron with a tensile strength up to 47,000 pounds per square inch, and authenticated tests have shown more than 50,000 pounds per square inch. But up to the time when the experiments reported by the speaker were made, there had been no British iron recorded of a strength of 35,500 pounds per square inch.

Carbon exists in iron as free or graphitic carbon and as combined carbon, it was said, and the best way to illustrate the difference between the two forms of carbon is to take a few turnings and rub them on the palm of the hand. If wrought iron, steel or white cast iron turnings are so rubbed, the hand will remain clean. But if the same thing were done with gray cast iron, or any iron containing free graphite, the hand would be polished with the praphite which would come out of the iron, showing the carbon to be in the free condition. The series of experiments which were made showed that one could commence with white iron and by adding silicon could convert the white iron into gray iron which would increase in the intensity of its grayness with the addition of silicon up to a certain point. It thus may be seen that there is a certain proportion of silicon which gives the best results.

The speaker said that Gautier in France, Keep in America, Ledebur in Germany, and a number of other observers took up the idea of strengthening cast iron by the addition of a suitable proportion of silicon. With the limited knowledge of metallurgy held at that time all sorts of mistakes were made. In the first place some tried to mix irons together without a proper knowledge of their composition, or without chemical analyses to guide them. Thus silicon was condemned, not for any fault of its own but because it was used in wrong proportions. Anyone observing the results of experiment would know at once that it is only with a correct percentage of silicon that a suitable result can be obtained.

Other experimenters neglected the fact that the metal would be profoundly influenced by the other constituents, such as sulphur, phosphorus, manganese or even total carbon. It may thus be seen that while silicon was the controlling element in the foundry one must always bear in mind that the proportion of silicon that would be required in a particular mixture would depend upon various circumstances. Professor Turner went on to say that the most important factors are first, the proportion of other elements that were present; and second, the rapidity of cooling, because rapid cooling tends to keep the iron and carbon combined. In other words chilling tends to retain the carbon in solution and to give a white iron, while slow cooling gives the graphite time to separate and make the iron more gray. A small casting will cool more rapidly than a big one, and a casting made in a chill will cool more rapidly than one cast in sand.

Professor Turner went on to say that it must be remembered that the effects of the proportion of silicon which was found in the iron in his experiments would only be the same when all circumstances were the same

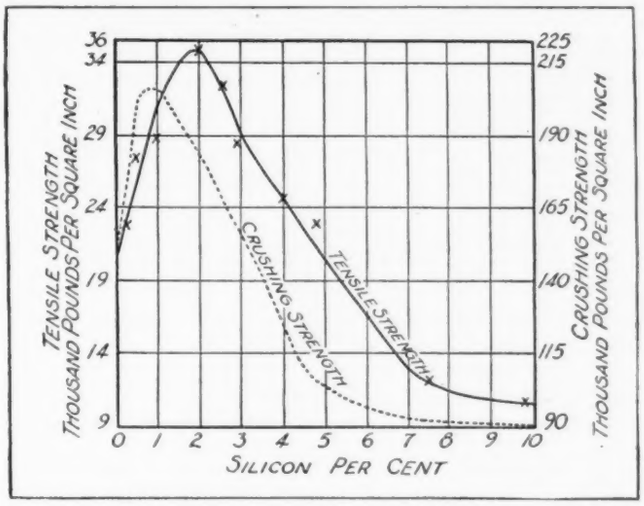


FIG. 1—THE HIGHEST TENSILE STRENGTH WAS OBTAINED WITH 1.8 PER CENT SILICON

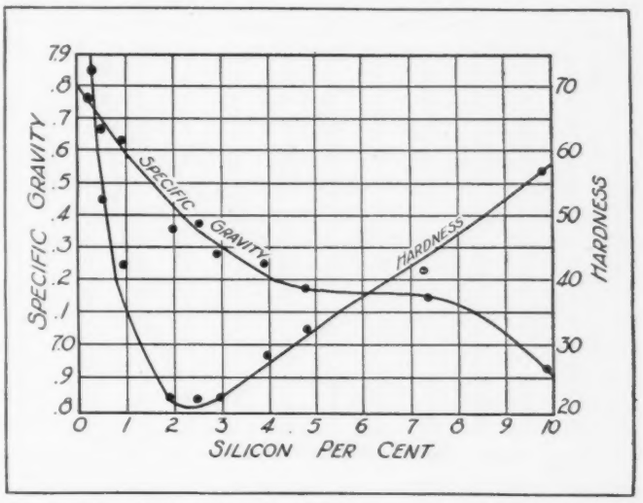


FIG. 2—HARDNESS DECREASED UNTIL THE IRON CONTAINED APPROXIMATELY 2.5 PER CENT SILICON

as they were in his experiments. There were three things to be remembered in reference to those circumstances: First, that a pure cast iron lower in carbon than usual was started with, so that there were no interfering elements present and nothing unusual except the somewhat smaller proportion of carbon; Second, that the casting was 1-inch in diameter and; Third, that his samples were all cast in an ordinary green-sand mold. Under those conditions 1.8 per cent, or thereabouts of silicon, will give the best tensile strength, so far as is known up to the present time.

Note Effects on Hqrdness

One of the most remarkable things in connection with silicon is its effect upon the hardness of cast iron. At the time of the author's experiments there was no method known of determining hardness in metals, that is, no recognized method, though there had been certain experiments along this line. Therefore, a method of testing hardness was devised by the author. A weighted diamond was used for this purpose and the diagram in Fig. 2 shows the effects on hardness of different proportions of silicon. The first sample contained practically no silicon and was sufficiently hard to scratch glass readily.

With the addition of silicon, the hardness rapidly fell until a material was obtained, which could be easily turned or cut. The iron with about 2.5 per cent silicon gave the maximum softness. The addition of more silicon increased the hardness. The changes showed that in all probability there are two effects proceeding side by side. There was an immediate effect, making the metal soft, and another effect, which came in more pronouncedly afterwards and made the metal hard. The explanation is that the silicon when first added threw the greater part of the carbon into the free form. The purer the residual iron, the softer it became until the point was reached where practically all the combined carbon was changed to graphite and the iron was perfectly soft and could not possibly be made softer. Therefore, all the silicon afterwards added, like any other element that went into solution tended to harden the iron. The formation of a solid solution always leads to a hardening of the iron; the silicon, even from the beginning, was hardening the iron, though this effect was disguised by that resulting from throwing out the carbon. As the carbon was thrown out the effect of the silicon was gradually more and more evident until the curve in the diagram became almost a straight line, indicating that the hardness increased proportionally with the increase of silicon.

Those experiments only dealt with metal containing up to 10 per cent silicon. Experiments since have been conducted by many manufacturers in different parts of the world, with the object of using ferrosilicon made in the electric furnace and containing higher percentages of silicon. Experiments have been made with proportions of silicon as high as 50, 75 and 90 per cent. On examining a melting-point diagram illustrating the properties of iron rich in silicon the important point to notice is that if a start is made with iron melting at 1500 degrees Cent. or thereabouts and silicon is added to it in successively increasing proportions, the melting point of the mixture falls until the relative proportion of silicon to iron, called a eutectic, is reached. This occurs when the proportion of silicon by weight is something under 20 per cent. On adding more silicon a compound, FeSi, which has a higher melting point is formed. With still more silicon addition a second eutectic is formed and then the melting point rises steadily to that of silicon, about 1425 degrees Cent. Therefore if it is desired to obtain a casting rich in silicon, as for instance, in making acid-proof vessels, as much silicon as can be introduced without reaching the eutectic point should be added. When that amount is passed, the melting point rises and a material is obtained which is difficult to handle. However, as long as the silicon is kept somewhere in the neighborhood of 18 per cent it is easy to melt the metal and pour it into a mold.

Influence of Carbon

It has been said that the effect of silicon depends upon the amounts of the other elements present, particularly of carbon. If the total carbon is high, in the neighborhood of 3.5 or 4 per cent, relatively little silicon is required to throw out some of the carbon in the form of graphite. It is known by experience that if the graphite begins to form and the metal is maintained at a high temperature the remainder of the carbon will precipitate out. But if the carbon is low, in the neighborhood of 2.5 or 2.75 per cent, it is necessary to add more silicon to throw the carbon out of solution. Enough silicon must be added to form the lower silicide of iron, and to leave behind only enough free iron to retain the carbon. In other words, the silicon for the purpose of solubility uses up some of the iron, and then begins to throw out the carbon. However, if there is little carbon present, more iron is free to be combined with some other element before the carbon can be thrown out. Therefore, the primary or fundamntal effect of silicon is upon the carbon. One result of this is that the more carbon that is thrown out of solution the less the metal contracts because the carbon is light and bulky when in the free state. Hence, in making a casting with white iron, more contraction must be allowed for than when making a gray-iron casting. When the white iron used in the malleable trade is annealed an expansion takes place, and the net result of the extra contraction and the subsequent expansion makes the contraction of malleable iron approximately the same as that of ordinary gray iron.

Contraction Test

There is no better rough test of the character of an iron than to determine its contraction. Such a test was first suggested by the late W. J. Keep, Detroit. The practice is to pour a small quantity of metal into a mold exactly 1 foot long. The ends of the bar are determined by a cast-iron yoke. After the bar has cooled a small wedge is put between the yoke and the bar to measure the amount of contraction. It has been found that the character of the product can be predicted with considerable certainty when its contraction is known.

If phosphorus and silicon are present together the result is gray iron with phosphide eutectic. The main portion of a deep gray iron is silicious iron or silico-ferrite and the graphite is in big flakes. Such an iron is not of the best grade. To improve the quality it is necessary to distribute the carbon and, as far as possible, to disseminate phosphorus.

The iron which has the best physical properties combined with good machining qualities, having density without undue hardness, a high tensile strength and a capability of wearing well, is one which contains just sufficient silicon to throw out the greater part of the carbon in the free state, but to leave sufficient combined carbon to be just under the eutectoid proportion.

Professor Turner said that the proper use of silicon is the key to the management of foundry irons. This can be done without any increased cost. It is not necessary to buy ferrosilicon, because pig iron can be secured containing enough silicon.

Steel Foundry Starts Operations—I

Sweep Is Moved Vertically on a Screw Spindle and Guided Horizontally by a Cam Groove on the Same Spindle — Drying and Annealing Ovens Have Been Built to Conserve Heat

SOARING prices of raw materials and steadily advancing labor costs make it essential for foundrymen to study more carefully than ever before, ways and means for reducing operating expense. Wages and material costs are items beyond the control of most producers of castings at the present time, and it is only by trimming expense items here and there that many are enabled to keep their production costs within bounds. An excellent example of the value of this attention to small particulars and the infinite number of small details which multiplied make up mounting expense, is furnished by the Vulcan Iron Works, Wilkes-Barre, Pa. This establishment which was described in the June 1 issue of THE FOUNDRY, was built last year. It was designed by Westinghouse, Church, Kerr & Co., New York, in accordance with the ideas of B. L. Weaver, foundry superintendent.

Since the plant has been put into operation, two prime principles of keeping down costs are emphasized. One of these is the insistence of mutual understanding between the engineer designing patterns and the foundryman, and the other is the operation of all the furnaces, ovens and other equipment to do the work at a minimum cost and save expense wherever possible.

B. L. Weaver, the superintendent, emphasizes the need of the engineer to understand and appreciate the foundry problems and the importance of the foundry calling attention of the engineer to changes which could be made in the design of the pattern to make the casting a more practical foundry problem. Two instances will suffice to show how mutual co-operation between the designing engineer and the foundryman developed the best means of making a casting.

Designs Are Changed

An example of this is a runner for a speed ring, shown in Fig. 5. The pattern as received by the foundry was not practical because the vanes were tapered almost to a feather edge and if molded that way they would have cracked. It also was found that the bands at the top and bottom needed a heavier finish than was allowed in the pattern in order to come clean when machined. The feather edges of the vanes were thickened to ½-inch and now the vanes are mechanically ground to a feather edge after the casting has been made and annealed. This grinding extends back from the edge 3 inches. The bands were made slightly heavier to allow more metal for finishing and the castings now are made with little difficulty. Both of these changes increased the cost of finishing, but more than saved this cost in decreased foundry losses.

The value of co-operation again was demonstrated when the pattern for the speed ring for a hydraulic turbine, shown in Fig. 6, gave trouble. The vanes of this ring are hollow and the sections of the vanes where they join the top and bottom rings are much thinner than the sections of the rings at these points. The vanes in such a casting naturally cool quicker than the rings by reason of this difference in section and the strain caused cracking. This defect was remedied by changing the radii of the vanes where they join the rings and adding more metal. It also was necessary to add metal to the top and bottom speed ring because the core which forms the hollow vane tended to rise or fall slightly and could not be held exactly in position. The increase of metal on the rings took care of the slight variation in the casting due to the core rising or falling. Portions of a mold for a similar casting are shown in Figs. 3 and 4. Fig 3 shows the drag which has

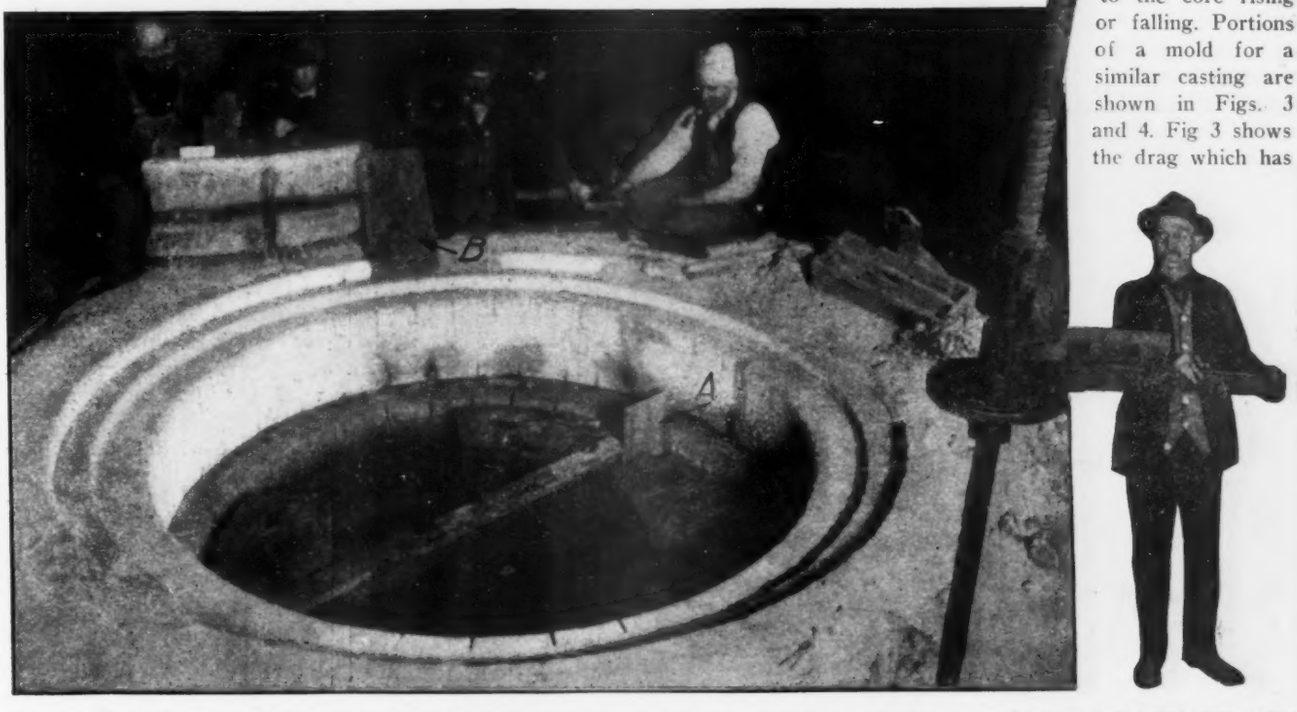


FIG. 1—THE MOLD FOR A STEEL DRUM IS SWEPT UP AND DRIED—CORES ARE THEN PLACED IN POSITION IN THE CENTER AND AFTER THE COVER CORES HAVE BEEN SET AND WEIGHED THE MOLD IS READY TO POUR—NOTE THE SPINDLE AND SWEEP TO THE RIGHT WITH THE CAM TO GUIDE THE ARM

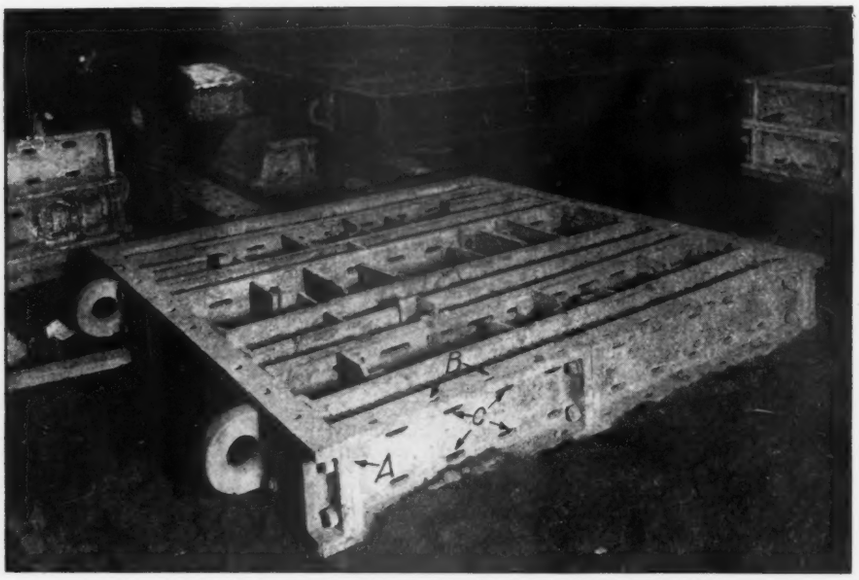


FIG. 2—FLASKS ARE BUILT FROM CAST-STEEL SECTIONS BOLTED TOGETHER

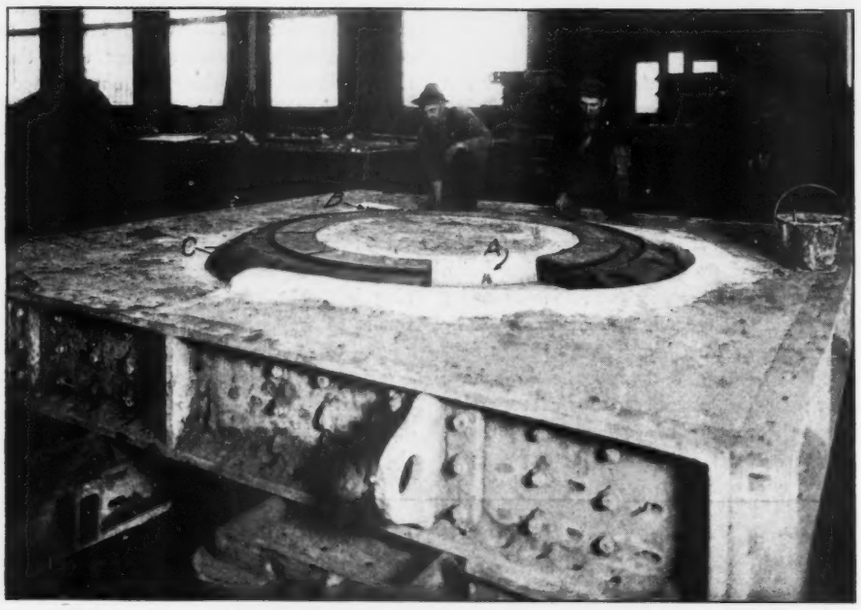


FIG. 3—THE DRAGS PORTION OF A SPEED RING MOLD AFTER PRELIMINARY DRYING

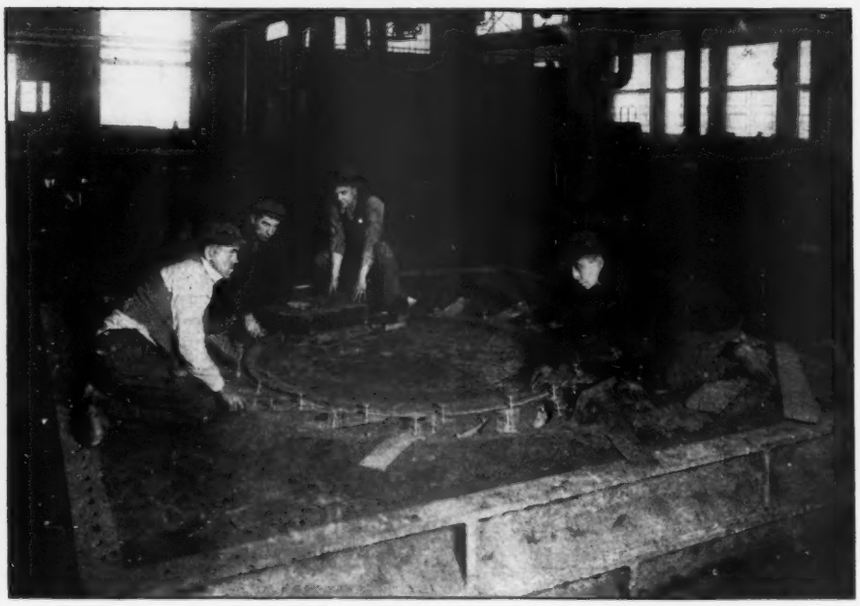


FIG. 4—CHEEK OF A MOLD FOR A SPEED RING—NOTE THE STEEL CHILLS UNDER THE CHAPLETS

been dried in the oven for 12 hours. The cores, shown as the darker portion, are located by *V* shaped notches in the mold as shown at *A*. The gate is a double swirl-type. The metal comes down through a round vertical gate to the drag and then flows through two horizontal runners at right angles to each other. These horizontal runners are set tangent to the ring. The entering metal, therefore, reaches the ring at two points simultaneously and is directed around the circumference. The location of the gate may be noted at *B*. As the cores are set, they are secured to the under side of the drag by wires fastened to gaggers or bolts. In this way the cores are held fast when the drag is turned over on the cheek which is shown in Fig. 4. Coreprints which form the hollows ni the vanes are located in the holes at *C*.

The cheek consists of three flasks of the same thickness as the one shown, and underneath them is a false cope. The flat strips under the chaplets are steel chills which cause the metal between the vanes to set quickly when the mold is poured. After the mold is ready for closing the drag is placed on top of the cheek and the whole bolted together. The entire mold then is rolled over on a plate so that the drag is underneath. The pattern in the cheek section is next withdrawn. The whole mold ready for casting is then placed in the drying oven and baked for 36 hours. It is necessary to give the drag a preliminary drying because of the size of the mold and the large amount of green sand at the center. Some molds, even though as large as this one, which have dried cores in the center, do not require preliminary baking of the drag.

Novel Spindle and Sweep

A mold in which the center is made of dried cores is shown in Fig. 1. This is made in six flasks 12 feet square and 12 inches deep. It is first swept up with the sweep shown in the insert, Fig. 1. This sweep travels on the screw spindle as shown. Each turn of the spindle raises or lowers the sweep arm a certain amount as determined by the screw. It can be used for different molds by changing the forming plate which is bolted on the end of the arm. The grooved ring shown travels vertically along the shaft and serves as a guide or cam, for the rotating sweep arm. The groove which is filled with oil regulates the arm of the spindle by grinding the cam roller which protrudes into it from the arm. The ring is not round but is formed by two semicircles joined by two straight lines. The cam in following this modified circle controls the movement of the sweep so that the resulting mold takes the same form. Thus the

casting which is made is not a true circle in horizontal section, but is in effect two semi-cylindrical sections joined by two

FIG. 5—THIN EDGES ON THE VANES OF THIS CASTING CAUSED CRACKING AS FIRST MADE

planes. The planes between the two cylindrical portions allow the casting to be split in halves without destroying the semicircular section. This is done after the casting is annealed and the two halves are obtained in a more exact circle than if they had been cast separately and been subject to the shrinkage strains the effects of which are more or less neutralized when both halves are made in the same casting. The straight lengths between the semicircular sections allow stock for splitting the pattern and the half cylinders then may be put together to form a cylinder without the use of liners. The large cores shown on top of the mold in Fig. 1 are placed on those already set to form a 3-inch band on the casting. Coring this band is found preferable to sweeping it in the mold as the latter method would require rodding the green sand of the mold and would cause difficulty in cleaning all of the sand out of the ring 3 inches high. A spacing board for gaging the distance between the two cores on either side of it may be seen at *A*, Fig. 1. The core which fits in this space may be seen at *B*. The board is used for getting the correct distance instead of the core. This is because the core is thin and probably would be broken if used for spacing. The mold had been dried 48 hours before work was begun putting in the cores. After all the central cores are in position cover cores will be placed on the mold and weighted down. The mold is then ready for pouring. There is a wide diversity in the size of the castings made by the Vulcan company and many orders are received for only one or, at the most, a few castings off of one pattern.

FIG. 7—THE DOUBLE-ENDED CORE OVENS HAVE LARGE CAPACITY

This necessitates a wide variety of flasks which may be combined to make a mold of any desired size or thickness. Flasks are made in sections 12 inches deep as a general rule. Then any number of flasks can be put together on top of each other to form a mold. These flasks are formed from plates bolted together as shown in Fig. 2. It may be noted at *A* how the end and side pieces are joined. Holes for bolting this section to one which may be added above it are shown at *B* and around the top flange. The crosspieces which, like the frame, are made of steel cast in the home foundry, are bolted to the sides and ends through holes as shown at *C*. They also may be bolted to each other as indicated by the long narrow slots in the cross pieces. From the frequency and length of these

FIG. 6—THE VANES ON THIS SPEED RING ARE HOLLOW AND THE THIN SECTION OF METAL IN THEM CAUSED TROUBLE UNTIL MORE METAL WAS ADDED WHERE THE VANES JOIN THE RINGS

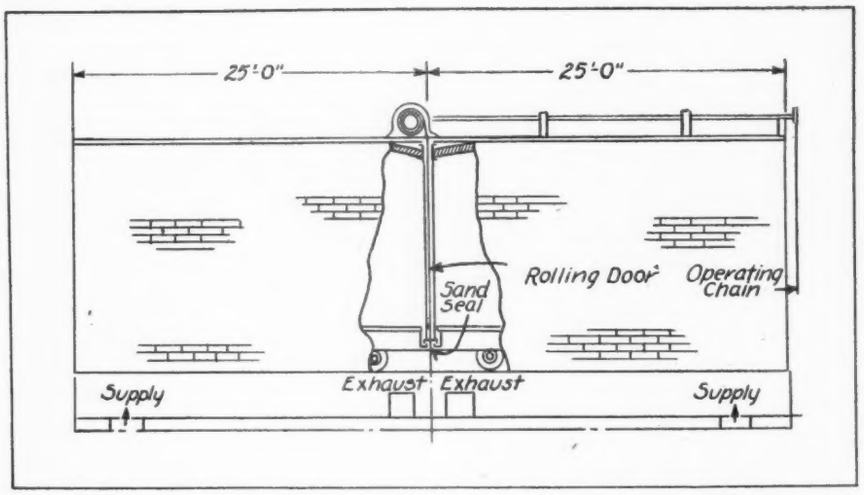


FIG. 8—CORE OVENS ARE BUILT SO THAT WHILE THEY CAN HOLD THE LONGEST MOLDS THEY CAN BE DIVIDED AND ONLY HALF OF THE OVEN USED WHEN ALL IS NOT NEEDED

slots it may be seen that any arrangement of crosspieces could easily be made to suit any mold.

A study of the design of the drying and annealing ovens and the operation of the open-hearth furnace reveals additional innovations which have been originated to reduce operating costs. Two car-type drying ovens are provided. These ovens have doors at both ends so that cars may be placed or removed through either end. One of the ovens is shown in Fig. 7. In this illustration a car of molds has been pulled from the oven and awaits unloading. The car is drawn from the oven by the crane shown in the illustration. A steel cable attached to the end of the car is passed through a sheave anchored in the floor opposite the oven door and is engaged by the crane hook. When the hook is raised the car is drawn forward. The same crane lifts the molds from the car and places them for pouring.

Heat Conserved

The ovens are built so that one sidewall is common to both as shown in Fig. 9. This reduced the first cost of the ovens and also conserves heat, for when both ovens are used simultaneously, heat does not escape to the outside through this wall but goes from one compartment to the other. Each chamber is 17 feet 7½ inches wide by 50 feet long by 11 feet 10 inches high from the platform of the truck which forms the oven bottom. This gives a large space to heat, and in order to conserve heat when a full charge is not available for drying, arrangements have been made to use only half of the oven. The division is secured by the use of a kinnear rolling door in the middle, as illustrated in Fig. 8. When the door is left down on a sand seal between the two cars, the half of the oven which is not charged is cut off.

The drying ovens are heated with anthracite coal, pea size being used. A fan *C*, Fig. 9, with a capacity of 6550 cubic feet per minute furnishes the blast. The heat goes up through the port along the inside wall of each oven into a long narrow chamber, marked *heat* in the illustration. This chamber extends the entire length of the oven and is covered at intervals with steel plates. These plates may be moved to regulate the flow of heat into different portions of the chamber and thus maintain an even temperature throughout the oven. After passing over the molds the gases are drawn out through ducts along the outside walls by fans. Unlike the arrangement for the blast in which one fan serves both ovens, a separate fan is provided for the exhaust of each. The fans both have a capacity of 3000 cubic feet per minute. The exhaust fans serve to draw the moisture from the cores and molds out of the ovens and have proved efficient for this purpose. Heat is prevented from escaping around the bottom of the trucks by a sand seal. The temperature is regulated according to pyrometers. Cores are heated to from

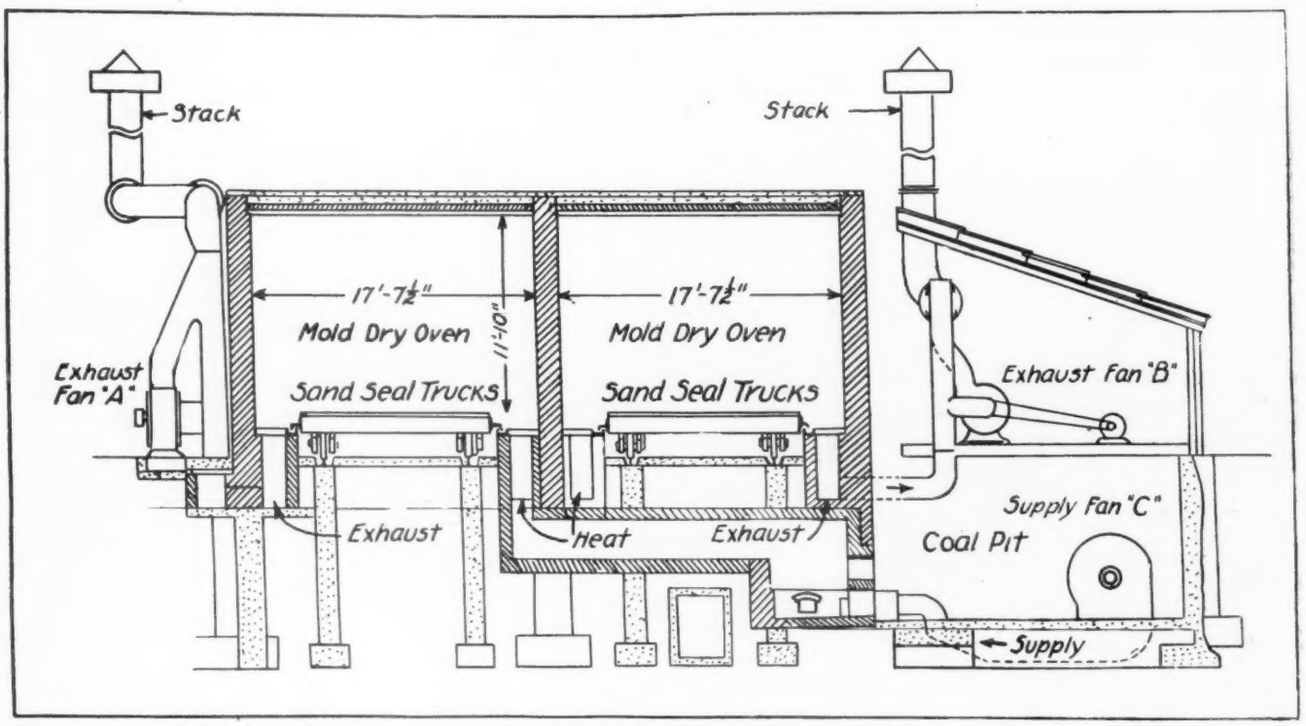


FIG. 9—A FAN SUPPLIES AIR TO BOTH DRYING OVENS BUT EACH OVEN HAS ITS INDIVIDUAL EXHAUST FAN—THE BOTTOMS OF THE CARS FORM THE FLOOR OF THE OVEN—SAND SEALS PREVENT HEAT FROM REACHING THE ROLLING MECHANISM

400 to 450 degrees Fahr. and molds are dried at from 700 to 900 degrees. The difference in temperature for drying the molds is accounted for by the size of the molds to be dried, larger molds requiring a higher temperature and a greater length of time than the smaller molds. The majority of the molds can be dried in 7 to 10 hours.

In addition to the two ovens described, two drawer-type core ovens have been installed for the smaller cores. These ovens also are heated with anthracite coal and equipped with thermometers. All ovens are designed so that fuel oil may be burned in place of coal should this be found expedient at any time.

Will Establish Branch in Nitro, Va.

The first commercial industry to locate at Nitro, W. Va., formerly the war department's "smokeless powder city" will be the Central Foundry & Supply Co., Columbus, O., which has purchased a factory site from the original purchasers, the Charleston Industrial Corp., of Charleston, W. Va. The sale has been approved by the ordnance salvage board and the director of sales, in accordance with a contract under which the government sold Nitro to the Charleston corporation last December. The site which was selected by the Central Foundry & Supply Co. consists of 5½ acres and contains such buildings as a sheet metal shop, a brass and iron foundry, a pipe and electric shop, a welding shop and numerous smaller structures. The purchasers will establish a branch plant at Nitro.

Apprentices Should Have Theory Training

By O. J. Rice

Believing that every man employed in an industry is an integral part of that industry and that the training of men should have at least as much attention as the improvement of machinery, I submit the following in support of C. C. Schoen's paper published in the Jan. 15 issue of THE FOUNDRY. My experience and observation gained in twenty odd years in the foundry industry leads me to believe that there is little attention paid to the development of good mechanics. In fact most of the competent mechanics have been developed in spite of the management rather than by the aid of the executive force. I have heard foundry managers lament the lack of skill and ability on the part of their employes. They seem to forget that these men were trained in some foundry, and they are limited by their training. Some men have labored under the delusion that the machine would eliminate the skilled molder, but have discovered later that intelligence and training were a considerable asset, even in the operation of a machine.

The United States government maintains apprentice schools in several of its manufacturing establishments and as a result there is more or less improvement in the skill and knowledge of its employes depending to a considerable extent upon the ability of the instructors and the attitude and support of the management.

There are many sound and pertinent suggestions in Mr. Schoen's paper that should be worked out. There could and should be established in every foundry center by the American Foundrymen's association, a school for foundry apprentices, making it a condition of employment, that the apprentice should attend this school. These schools should be presided over by practical foundrymen with the assistance of the technical instructors in our established schools. The cost is not worth considering in view of the great amount of money spent on other forms of experimental work. It has been fairly well established that the practical man (intelligence being equal) is superior in some respects to the technical man, and it follows by the same line of reasoning that the practical man who has supplemented his knowledge by a technical training should be superior to both.

Book Review

Little Known Facts About Grinding, by Howard W. Dunbar; leatherette, 174 pages, 4½ x 7 inches; published by Norton Co., Worcester, Mass.

In this book Mr. Dunbar has collected a number of practical articles and suggestions on grinding that have appeared from time to time in *Grits and Grinds,* a house paper published by the Norton Co. for several years. The book is divided into two sections, the first being devoted to little known facts while the other describes practical grinding kinks.

The first section of the book covers 41 separate subjects, each of which is treated in a comprehensive manner. An interesting chapter is devoted to grinding machine operations in which various points that should be given attention by every operator are described. Another interesting chapter pertains to cam checking and actual instances of how trouble with cams checking during the grinding operation was overcome, are given. Among other interesting subjects covered are: Wheel truing, wheel grades, surface grinding, chatter marks, cam grinding, wheel balance, steady rests, soft wheels, grinding lubricants, etc.

The grinding kinks furnish interesting reading as they are taken from actual working conditions and show economical methods for handling grinding in actual production work. The book is well written in clear, comprehensive language and it will prove an excellent handbook for the grinding machine operator, the grinding room foreman, the mechanical engineer and the student of grinding.

Investigate Method for Determining Oxygen

Equilibrium conditions in the system carbon, iron oxide and hydrogen in relation to the Ledebur method for determining oxygen in steel were studied by the bureau of standards. The results are published in scientific paper No. 350 of the bureau. The conclusions of this investigation are that graphite does not reduce ferrous oxide or water vapor at 900 degrees Cent. if hydrogen is passing at the rate of two liters or more per hour.

Combined carbon in iron reduces ferrous oxide, with formation of carbon monoxide, under the foregoing conditions, to an extent varying with the proportion of carbide present.

The percentage of ferrous oxide reduced by hydrogen from a mixture of iron carbide with ferrous oxide is a function of the rate of passage of the hydrogen and, as shown by experiments in this paper, reaches a maximum of 75 per cent reduction when hydrogen passes at about three liters per hour. The remaining oxygen is evolved principally as carbon monoxide and partly as carbon dioxide.

The Ledebur method under most favorable conditions probably can not account for more than 75 per cent of the oxygen present in a steel as ferrous oxide.

The Hagerstown Homes Corp. has been organized by approximately 50 manufacturers, merchants and bankers of Hagerstown, Md., and to relieve the acute situation existing in that community due to the house shortage, this corporation is preparing to build annually 100 or more modern houses for workmen. These houses will sell for about $3500 each and may be purchased on an easy payment plan. Thomas W. Pangborn, president of the Pangborn corporation, is president of the Housing Corp.; John J. Porter, vice president of the Security Lime & Cement Co., is first vice president, and Henry Holzapfel Jr., second vice president.

Graphitization of White Cast Iron

Experiments Show Results Which Would Revolutionize the Theory of Annealing Malleable Iron — Graphitization Completed in White Cast Iron at Temperatures Below the Critical Point

BY R. S. ARCHER

Investigations Enlighten Annealer

ANNEALING is one of the principal steps in the manufacture of malleable-iron castings. This process is carried on to change the carbon, which is all in the combined state in the original hard iron, into free or temper carbon. The operation sometimes is known as graphitization. The first rules for annealing were evolved from experience based on certain given conditions and a limited knowledge of the metallurgy of malleable. More recently investigations have been carried out to determine the effects of different annealing temperatures on the product. Some of these experiments have revealed important facts and have in a measure changed annealing conditions in a number of foundries. The paper here presented reveals some new facts which should be helpful to the industry, in that they show complete graphitization occurs at a temperature below the A_1 point, and that it cannot be completed at a temperature close to this point.

THE proper representation of equilibria involving graphitic carbon in the constitutional diagram of the iron-carbon system is admittedly an unsolved problem. The complete solution of the problem will probably require the establishment of more experimental evidence than is at this time available. This paper presents the author's observations on some of the phenomena in question and his interpretation of this and other recorded evidence. The chief of the recently disputed questions upon which the author has experimental evidence concerns the occurrence of graphitization at temperatures below the A_1 point. In a paper presented at the September, 1919, meeting of this Institute, the following is found: "The results given would seem to indicate that the graphite eutectoid lies at a smaller value of carbon content than has been previously supposed. At least this is true unless there is either a marked formation of graphite eutectoid at these rates of cooling, or a decomposition of pearlite into graphite, both rather unlikely suppositions, but not impossible ones."

In a discussion of this paper, H. A. Schwartz takes the position that the possibility of graphitization occurring below the A_1 point is an open question, but that complete graphitization, to less than 0.10 per cent combined carbon, commonly occurs above this temperature.

Another opinion from the malleable castings industry is found in a recent paper by Touceda: "Also the carbide of iron can be broken up into its two soft constituents at the temperature referred to. This temperature is called the critical temperature, or critical range, and for air-furnace hard-iron castings it is in the vicinity of 1440 degrees Fahr. It is the lowest temperature at which hard-iron castings may be successfully annealed. This statement must be modified by the further statement that in an oven under perfect control this temperature is the one that would be selected. In practice, it would not be safe to adhere too closely to it, for the reason that should the castings while being held at temperature fall under the critical range, it would undo in large measure what had been accomplished above it." It is not certain that the "critical temperature" referred to is understood by Touceda to be the A_1 point of the iron-cementite system, but 1440 degrees Fahr. is certainly at or above the A_1 point of the hard-iron mentioned. It therefore seems to be his opinion that graphitization cannot be carried out below the A_1 point, and that heating a partly graphitized iron below this temperature will cause a reversal of the process.

The author questions the statements quoted and will try to show, first, that graphitization can be initiated and completed, to less than 0.05 per cent combined carbon, at temperatures below the A_1 point; second, that complete graphitization is possible only at or below a point which is very close to, if not identical with, the A_1 point.

Practically all of the available evidence on graphitization concerns iron-carbon alloys rather high in silicon, since these are the most easily graphitized. It is therefore important to know the effect of silicon on the position of the A_1 point. Some determinations of the Ar_1 point recorded in the literature show it to range from 730 to 750 degrees Cent. An unpublished heating curve plotted from data taken in the laboratories of the General Motors Corp., Detroit, by C. Pfeifer gives 760 degrees Cent. as the Ac_1 point for an iron containing 0.85 per cent silicon. These results are all consistent, with the possible exception of that of Charpy. The conclusion seems justified that the presence of 1 per cent of silicon raises the Ac_1 point to at least 740 degrees Cent. (1364 degrees Fahr.) and more probably to about 765 degrees Cent (1409 degrees Fahr). Since graphitization is a slow process, the critical temperature in question is the A_1 point, which is generally considered to lie between Ar_1 and Ac_1, but much nearer to Ac_1. For a 1 per cent silicon iron, A_1 is probably within 15 degrees Cent. of 750 degrees Cent.

In a previous paper, rates of graphitization at various temperatures were given for a hard-iron containing 1.05 per cent silicon. Two of the annealing treatments carried out for the determination of these rates are believed to have been conducted entirely below the A_1 point and there is no question that they produced complete graphitization. The mean temperatures were 690 degrees Cent. and 735 degrees Cent. and no deviations from these temperatures greater than 15 degrees Cent. were observed during the heat treatments. The furnace used was not automatically controlled nor was a temperature recorder available. Therefore the following indirect evidence is submitted that the annealing temperatures remained below A_1. Microscopic examination of every specimen of the two series showed that in all cases the pearlite was in the *divorced* state. This could not have been the case if the temperatures had oscillated about the A_1 point. The results of experiments at 785 de-

A paper prepared for the New York meeting of the American Institute of Mining and Metallurgical Engineers. Copyright by the A. I. M. M. E. R. S. Archer is metallurgist, Aluminum Manufactures, Inc., Cleveland.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

FORMULAS FOR THE BRASS FOUNDRYMAN

Hardening Effect of Bismuth on Tin

Alloy No. 1	Per cent	Alloy No. 2	Per cent
Tin	99.50	Tin	99.00
Bismuth	0.50	Bismuth	1.00

The hardness of No. 1 alloy unannealed was 11.90, and when annealed 11.75. The hardness of No. 2 alloy was 14.85 unannealed and 14.30 when annealed. With higher percentages of bismuth the hardening effect was more evident.

Alloy No. 3	Per cent	Alloy No. 4	Per cent
Tin	96.00	Tin	92.00
Bismuth	4.00	Bismuth	8.00

The hardness of No. 3 alloy was 26.65 unannealed, and 25.60 when annealed, that of No. 4 was 29.25 unannealed, and 28.90 when annealed.

Hardening Effect of Aluminum and Magnesium on Tin

Alloys			Comparative Hardness Averaged		
Tin Per Cent	Aluminum Per Cent	Magnesium Per Cent	Chilled Casting	Annealed 3 Hours	Annealing Temperature Degrees Cent.
99.75	0.25	00	14.25	12.75	210
99.50	0.50	00	16.50	13.50	210
99.00	1.00	00	17.35	14.35	210
98.00	2.00	00	20.15	14.25	210
99.50	00	0.50	20.05	15.80	180
99.00	00	1.00	25.50	15.65	180
98.00	00	2.00	31.85	18.50	180

In the above tests the great hardening effect of magnesium is illustrated and in this connection the great effect that annealing has in softening these alloys may be pointed out.

FORMULAS FOR THE BRASS FOUNDRYMAN

Comparative Hardness of White Metals

The following results in regard to the hardness of white metals were obtained by the researches of P. Ludwik. The tests were made by the conical impression method.

Alloys				Comparative Hardness		
Tin Per Cent	Lead Per Cent	Antimony Per Cent	Copper Per Cent	Chilled Castings	Annealed 3 Hours	Annealing Temperature Degrees Cent.
96.00	4.00	00	00	13.35	14.55	150
92.00	8.00	00	00	16.00	14.30	150
85.00	15.00	00	00	15.50	14.15	150
70.00	30.00	00	00	11.50	12.70	150
50.00	50.00	00	00	9.90	10.15	150
96.00	00	00	4.00	12.75	11.75	200
92.00	00	00	8.00	15.50	14.55	200
85.00	00	00	15.00	24.30	23.45	200
96.00	00	4.00	00	16.60	14.80	200
92.00	00	8.00	00	21.10	21.15	200
85.00	00	15.00	00	25.25	23.00	200
70.00	15.00	15.00	00	20.35	22.35	150
55.00	30.00	15.00	00	15.10	18.55	150
88.00	00	8.00	4.00	27.20	23.60	200
84.00	00	8.00	8.00	30.15	27.70	200
81.00	00	15.00	4.00	29.30	26.60	200
77.00	00	15.00	8.00	33.90	33.20	200

From the above it will be noted that lead has a softening effect on tin, and that copper and antimony together have the greatest hardening effect.

Hardness of Alloys of Tin and Zinc

Alloy No. 1	Per Cent	Alloy No. 2	Per Cent	Alloy No. 3	Per Cent
Tin	99.50	Tin	99.00	Tin	96.00
Zinc	0.50	Zinc	1.00	Zinc	4.00

The hardness of No. 1, was 11.15, unannealed and 10.35 annealed. Of No. 2, 14.10 unannealed and 14.15 annealed, of No. 3, 17.00 unannealed and 15.45 annealed.

grees Cent. showed that at that temperature, which is not far above A_1, an annealing period of 10 hours produced about 0.5 per cent of graphitic carbon in this iron. In the 690 degrees Cent. treatment, only 0.06 per cent graphitic carbon was found after 24 hours. The progress of graphitization during the 690 degrees Cent. and 735 degrees Cent. treatments is shown in Table I.

The material used for these experiments was a lot of hard-iron bars ⅜ inch square cast from a single ladle of metal in a green-sand mold. The analysis was: Total carbon, 2.90 per cent; graphitic carbon, none; silicon, 1.05 per cent; manganese, 0.35 per cent; sulphur, 0.035 per cent; phosphorus, 0.11 per cent. The test pieces were heated in a wire-wound electric furnace and due precautions were taken that the temperatures indicated were correct and represented the actual temperatures of the test pieces. The furnace chamber was filled with charcoal but not in contact with the test pieces. This resulted in fairly satisfactory protection from decarbonization, and microscopic examination showed that in no case was a ferrite rim formed. After the specified periods of annealing, the specimens were removed from the furnace and dropped into a box of ashes. The time of cooling from the annealing temperature to below a red heat did not exceed 20 minutes. Opposite sides of the test pieces were ground down about $\frac{1}{32}$-inch and drillings taken for analysis, the drill passing through the test piece. From these drillings samples were taken by the parting method. The samples for total carbon were not screened. Both total and graphitic carbons were determined by combustion.

A different line of evidence concerning the temperature ranges of graphitization is furnished by reheating a completely graphitized iron. Specimens were prepared from a malleable test bar in the form of cylinders ⅝-inch in diameter by 1-inch in length. A ⅛-inch hole was drilled down the axis of the specimens to a depth of ½ inch. A thermocouple, especially checked for the purpose, was packed into this hole with asbestos, which insulated the wires of the couple from the sides of the hole and from each other. The specimen was then heated to a specified temperature, the rate of heating being quite slow as the required temperature was approached. The specimen was held at this heat for 15 minutes and then cooled in air.

The structures of two such specimens are shown in Figs. 1 and 2. Both are etched in an alcoholic solution of picric acid and magnified 100 times. It will be noted that the specimen reheated to 749 degrees Cent. (1380 degrees Fahr.) shows no combined carbon, while the one heated to 771 degrees Cent. (1420 degrees Fahr.) does show combined carbon. It was not considered necessary to analyze this material. This reversion of graphitic carbon to combined carbon has been observed and recorded by Touceda, who found no combined carbon on reheating to 760 degrees Cent. but did after heating to 788 degrees Cent. A similar observation is reported by Storey and Leasman.

It therefore appears to be a well-established fact that there is a temperature above which the graphite of a completely graphitized iron will go back into solution, to be reprecipitated on cooling as iron carbide. For iron of the composition used for malleable castings—0.5 to 1 per cent silicon—this temperature is approximately 765 degrees Cent. The conclusion seems inevitable that combined carbon cannot be completely converted to graphitic carbon under conditions that cause graphitic carbon previously formed to

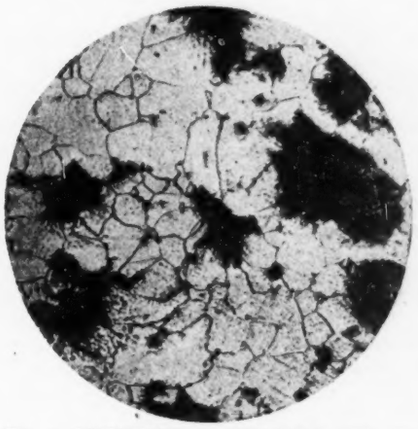


FIG. 1—MICROGRAPH OF MALLEABLE IRON REHEATED TO 749 DEGREES CENT.

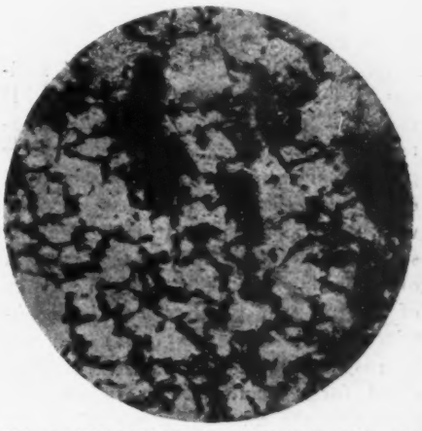


FIG. 2—MICROGRAPH OF MALLEABLE IRON REHEATED TO 771 DEGREES CENT.

Table I

Solubility of Graphite in Iron

Test No.	Annealing Temperature Degrees Cent.	Annealing Temperature Degrees Fahr.	Time at Heat, Hours	Total Carbon, Per Cent	Graphitic Carbon, Per Cent	Combined Carbon Per Cent
F-1	835	1535	5	2.87	0.54	2.33
F-2	835	1535	9	2.83	1.41	1.42
F-3	835	1535	19	2.80	1.96	0.94
F-4	835	1535	24	2.76	1.93	0.83
E-1	785	1445	41	2.76	1.76	1.00
E-2	785	1445	45	2.80	1.87	0.93
E-3	785	1445	50	2.72	1.96	0.76
E-4	785	1445	55	2.73	2.07	0.66
E-5	785	1445	65	2.75	2.07	0.68

Table II

Progress of Graphitization in Malleable Iron

Test No.	Annealing Temperature Degrees Cent.	Annealing Temperature Degrees Fahr.	Time at Heat, Hours	Total Carbon, Per Cent	Graphitic Carbon, Per Cent	Combined Carbon Per Cent
D-1	690	1274	24	2.80	0.06	2.83
D-2	690	1274	47	2.75	0.47	2.28
D-3	690	1274	75	2.87	1.31	1.56
D-4	690	1274	95	2.87	1.82	1.05
D-5	690	1274	119	2.80	2.33	0.47
D-6	690	1274	149	2.77	2.49	0.28
D-7	690	1274	168	2.75	2.70	0.05
D-8	690	1274	193	2.68	2.68	None
D-9	690	1274	221	2.76	2.75	None
C-1	735	1355	11	2.92	0.12	2.80
C-2	735	1355	24	2.90	0.39	2.51
C-3	735	1355	37	2.93	1.27	1.66
C-4	735	1355	48	2.78	1.83	0.95
C-5	735	1355	60	2.74	2.05	0.69
C-6	735	1355	72	2.74	2.31	0.43
C-7	735	1355	84	2.76	2.42	0.34
C-8	735	1355	96	2.68	2.50	0.18
C-9	735	1355	120	2.58	2.51	0.07
C-10	735	1355	150	2.56	2.51	0.05

revert to dissolved carbon and, on moderately rapid cooling, to cementite. That is, it is not possible above this critical temperature to completely convert combined carbon to graphitic carbon. If this is true, it follows that the complete conversion regularly obtained in properly annealed malleable castings must, of necessity, take place in its final stages either at or below this critical temperature.

Temperature of Conversion

Whether the completion of graphitization takes place at or below a definite critical temperature is a question of importance. If, as maintained by some of the writers quoted, the complete conversion to graphite takes place at this critical temperature and not below it, such conversion must consist in the direct precipitation of an iron-graphite eutectoid. For if the conversion took place simultaneously with the formation of pearlite, there is no reason to suppose that it would not continue at temperatures slightly below the critical.

When white cast iron is heated sufficiently long at temperatures above 785 degrees Cent., the combined carbon content reaches a constant value for any given temperature. It has been well established that these values increase with the temperature. It is by plotting such values against the temperatures of annealing that the solubility curve of proeutectoid graphite has been obtained. This curve, as Desch remarks, is suspiciously close to the solubility curve for cementite. The author suggests that the solubility curve of graphite can, for practical purposes, be considered to be identical with that of cementite, if due allowance is made for the effect of silicon on the solubility of cementite, and on the temperature of the A_1 change. In the experiments referred to above to determine rates of annealing, some evidence was obtained as to the solubility of graphite in iron containing 1.05 per cent silicon at temperatures just above A_1.

The method of cooling after the annealing period seriously affects the results of such experiments. The test pieces of set *F* were air-cooled after being withdrawn from the furnace. A piece similarly treated but quenched showed a combined carbon content of 0.86 per cent. This may indicate a slight additional precipitation of graphite during air cooling, but the difference is within the errors of analysis. Another test piece was cooled from the same temperature under ashes, as described; the combined carbon content was then 0.67 per cent. This shows that the short time occupied in passing through Ar_1 and through temperatures immediately below Ar_1 was sufficient to allow the formation of nearly 0.2 per cent more graphitic carbon. It is thought that the sensitiveness of such material to slight changes in the cooling rate has not been sufficiently appreciated, and that this accounts for some apparently inconsistent results in the literature.

As stated above, the test pieces of set *F*, after air cooling and after quenching gave consistent results, so that the value 0.85 per cent is considered to be a reliable figure for the solubility of graphite at 835 degrees Cent., in the presence of 1.05 per cent silicon. The test pieces of set *E*, however, were cooled under ashes, so that the results only show the solubility at 785 degrees Cent. to be between 0.66 and 0.85 per cent. Since this temperature is only slightly above A_1, assumed to be at 765 degrees Cent., it is thought that this evidence points to a eutectoid composition in good agreement with that given by Guertler—0.70 per cent.

When allowance is made for the chemical effect of silicon and phosphorus, and for the bulk effect of graphite, on the composition of the pearlite eutectoid, it is the author's opinion that 0.70 per cent carbon is so close to the value to be expected that the iron-cementite and iron-graphite eutectoids may be considered as practically identical.

The evidence submitted in this article is thought to demonstrate two facts: That graphitization can be initiated and completed in a white cast iron at temperatures below the A_1 point; and that graphitization cannot be completed at temperaures above a point which is very close to and perhaps identical with the A_1 point.

Theory of Graphitization

It is suggested that the phenomena of graphitization can be satisfactorily explained on the basis of the following theory: First, with the possible exception of the initial stages, graphitization takes place directly from solid solution: Second, graphitization may take place from any solid solution supersaturated with respect to graphitic carbon: Third, the evidence at present available is not sufficient to determine whether the saturation values for a solid solution on the point of precipitating graphite are appreciably different from those for a solid solution on the point of precipitating cementite. Under conditions of equilibrium, two phases are present—graphitic carbon and the saturated solid solution. Metastable equilibrium may exist between the two phases iron carbide and solid solution. Theory indicates that the carbon concentration of solutions in stable equilibrium with graphite is less than that of solutions in metastable equilibrium with iron carbide. If the available experimental evidence is considered with allowance for the effect of impurities on the solubility of iron carbide, the solubility curve of the carbide may, for practical purposes, be used to determine the conditions of equilibrium in the stable system iron graphite.

Heat Treatment Strengthens Duralumin

HEAT treatment of duralumin was investigated by P. D. Merica, R. C. Wattenberg and H. Scott of the bureau of standards. The results of the investigation which have been published point out that the unusual feature of this alloy is the fact, as was shown by A. Wilm, that it can be hardened quite appreciably by quenching from temperatures below its melting point followed by ageing at ordinary temperatures, which consists merely of allowing the material to stand at these temperatures. The hardness is not produced by the quenching alone, but increases during the period of ageing, which may be from one to three days. Cohn gives data showing the increase of hardness of duralumin during ageing, after quenching in water from about 450 degrees Cent. Upon annealing the alloy so hardened by ageing, it is softened exactly as is hardened steel.

The composition of this allow usually varies within the following limits:

	Per cent
Copper	3.0–4.5
Magnesium	0.4–1.0
Manganese	0.0–0.7
Aluminum	Balance
Iron (as impurities)	0.4–1.0
Silicon (as impurities)	0.3–0.6

Its density is about 2.8. It is used only in the forged or rolled condition.

This alloy has been produced for some years commercially and is in demand for the fabrication of parts for which both lightness and strength are required, such as for aircraft. Its tensile strength will average 50,000 to 60,000 pounds per square inch after appropriate heat treatment, such as that described by Wilm.

With the purpose of ascertaining whether the treatment described by him actually developed the best mechanical properties possible for duralumin, a

study was undertaken of the effect of variation in heat-treatment conditions, that is, quenching temperature, ageing temperature, etc., upon these properties and, a study of the effect of chemical composition upon them.

Details of the tests including micrographs showing the microstructure of duralumin are given.

Conclusions are drawn relative to the best conditions for commercial heat-treating practice for this alloy. The temperature of quenching should not be above that of the $CuAl_2$ aluminum eutectic, which is usually about 520 degrees Cent., but should be as near to this as possible without danger of eutectic melting. The pieces should be held at this temperature from 10 to 20 minutes and quenched preferably in boiling water. The hardening may for most purposes best be produced by ageing for about five days under a temperature of 100 degrees Cent.

A theory of the mechanism of hardening of duralumin during ageing, after quenching from higher temperatures, was developed which is based upon the decreasing solubility of the compound $CuAl_2$ in solid solution in aluminum with decreasing temperatures from 520 degrees Cent. to ordinary temperatures. It is believed that the precipitation of excess $CuAl_2$ which is suppressed by quenching proceeds during ageing, the precipitation taking place in very highly dispersed form. The hardening is due to the formation of this highly dispersed precipitate.

According to this theory the hardening of duralumin during ageing or tempering after quenching presents a very close analogy with that of steel, and the evidence in support of the theory is of the same nature and of approximately the same competence as that in support of the prevailing theory of the hardening of steel.

How and Why in Brass Founding

By Charles Vickers

Sands For Brass Casting

We are making a quantity of plain sleeve and flange bushings ranging in weight from 3 pounds to 50 pounds each. The larger castings are molded upright; are gated at the bottom with two gates which spread from the bottom of the sprue like a crescent, often known as a frog gate, and the fall of the metal is broken by offsetting the sprue at the cope joint. The molds are rammed on plain jolt machines, and a green sand core is used for the inside of the bushing. The alloys used consist of the following mixtures: (1) *copper, 88 per cent; tin, 10 per cent; zinc, 2 per cent.* (2) *Copper, 80 per cent; tin 10 per cent; lead 10 per cent.* (3) *Copper, 85 per cent; tin 5 per cent; zinc 5 per cent; lead, 5 per cent.* (4) *Copper, 83 per cent; tin, 4 per cent; lead, 6 per cent, and zinc 7 per cent. The difficulty we experience is caused by small sand holes in the surfaces of the castings. The difficulty is not constant we will have none of it whatever for several months, then all at once with the same work, gated in the same way and all other conditions apparently identical, we will find the castings machining hard, small pockets of sand close to the surface, sometimes on the inside, sometimes on the outside of the castings. We have established to our satisfaction that the sand does not come from the cores; it appears to get away from the gate, and from the mold in small particles. We are sending a sample of the sand for inspection. This sample has been used, and is an Albany No. 0 purchased some time ago. Can you advise us as to the cause of this difficulty, and just what is the matter with the sand? We make about 5 tons of castings from each heap of sand per month, and every month we dry all the sand, and put it through a fine riddle, then add about 30 per cent of new sand.*

An examination of the sand shows it to be a good grade of No. 0, brass molding sand. When wetted, the moisture soaks right into the sand showing that it does not contain too much clay for molding purposes. On the contrary it appears to lack bond and if the sand heaps are all like the sample it would appear the sand will require to be worked quite damp to get the necessary stability for the mold. This would favor scabbing and cutting, of which there are many degrees; one of them being the trouble experienced. The practice of drying the sand monthly is excellent from the viewpoint of metal recovery, but it fails to keep the sand piles in condition. This can be done only by the constant addition of new sand.

It would appear that additions of new sand are only made at monthly intervals, when it should be made two or three times a week. Regarding the intermittent character of the trouble, the reason for this can only be determined as a result of a careful study of the sand piles from day to day to determine if the sand gets progressively weaker, and if, when this occurs, the difficulty from sand deposits appears in the castings. This study would show if it is possible to eliminate the difficulty by the use of a stronger molding sand. This study should be undertaken for the satisfaction of all concerned, as there is no mystery about the disappearance and recurrence of the sand specks in the castings. They are due to natural causes, and can be eliminated by an analysis of the situation.

However, there is a shorter cut to the elimination of the difficulty. It is all caused by the use of too fine a sand for the weight of the castings. A thin-walled bushing 12 inches deep as some of the castings are, should never be molded in a No. 0 sand. If the sand has the necessary plasticity, it will be too *close*, if it has the necessary *openness* as in the present case, it will lack strength, and it will wash either *en masse*, or in single grains before the entering metal, the result being different in degrees, but the same in character. It is a mistake to assume that a coarse sand produces a rough casting; it will only do this for a certain character of castings. Thus for chandelier castings, it is necessary to use a fine grade of sand, otherwise, they will be too rough. This applies also to all thin, light work. For machinery castings, bushings, etc., a No. 1 sand will produce a smoother casting than the finer grades of molding sand. A No. 1 sand is as fine as should be used for making bushings as large as the ones mentioned. We suggest that a few barrels of both No. 1 and No. 2 molding sand be procured for experimental use. The addition of about 50 per cent of one of coarser sand to the present piles will cure the trouble. A sand is required that will vent freely, but will contain sufficient bond to prevent the individual grains from being washed away by the streams of metal, and also will not flake. When the sand is too fine for the weight of the casting, spots covered with a greenish coat, that are difficult to brush off will be

observed in cleaning the castings. Underneath these greenish spots defects usually are located. The remedy is to use a coarser sand, even if this necessitates throwing away the entire molding sand supply that has been in use.

Brass Hardware Castings

We intend to make brass castings for furniture hardware using an alloy containing copper, 65 per cent, and zinc, 35 per cent. We would like to know what the loss will be with this alloy and what will be the best way of melting it. Also we would like to get the dimensions of furnaces burning coke with forced draft suitable for Nos. 50 and 25 crucibles and what is the best kind of coke to use in this connection.

The loss in melting yellow metal will vary with the melter and the kind of furnace that is used. The average melting loss in oil-fired furnaces may be placed at 4 per cent. Some founders cut this loss in half and with others it is much higher. Melting in a crucible can be figured as not excessive if the loss is kept to 3 per cent, but this figure may be improved upon. The best way of melting this alloy is in crucibles. If new metal is made, charge the copper first and melt under a cover of charcoal, with a little salt as a flux. Have the zinc warm at the start and add a few small pieces to the copper, then follow with the larger pieces. Do not hold the brass in the furnace but remove it as quickly as the pouring temperature is reached. This temperature may be determined for thin castings, by holding an iron bar in the metal and noting the tremor that is communicated to the bar. If no tremor is felt the metal is too cool to pour. A No. 50 crucible coke-fired furnace should be 17 inches in diameter inside the firebrick and the depth of shell should be 28 inches. For a No. 25 crucible, the furnace should be 14 inches in diameter and 25 inches deep. These dimensions permit the use of coke that is not broken too finely to burn well. A No. 35 crucible is a good size for yellow brass, and the furnace should be 15 inches in diameter. A coke low in sulphur should be used.

Casting Iron Around a Brass Lining

We have tried to cast a heavy veneer of brass onto the bearing portion of a cast iron pillow block. We first cast the brass, then incorporate it into the core that forms the bearing and set it into the mold, then pour the cast iron into the mold. The difficulty is caused by the brass becoming liquid, and remaining in that condition long after the iron has solidified, during which period, owing to the great degree of fluidity imparted to the brass, it seeps into the sand backing of the mold and core, also the fluid brass follows up the shrinkage of the cast iron, getting between the latter and the sand of the mold, the result being that the brass is taken away from the bearing part where it is wanted. We would like to learn if a cast iron chill back of the brass would prevent the latter from melting. Also if it would be possible to cast the brass into the iron without the shrinkage producing a loose fit.

As the brass is entirely enclosed by the iron on all but the curved side, and the iron is 3 inches thick, it is doubtful if a chill behind the brass would keep the latter entirely in a solid state. However, the chill would greatly aid in keeping the brass from melting, especially if the iron is poured at as low a temperature as is possible to pour the casting. On this account, it is worth a trial. The brass would have to be in intimate contact with the chill to derive any benefit from its chilling influence. Casting the brass onto the iron can be done, provided the iron is hot and the brass is flowed through the mold. However, the shrinkage of the brass might cause it to become loose. We believe that if a chill is placed against the brass, and a riser on the mold over the brass, and the iron is poured cool that a successful job can be made. After the iron is poured, look down the riser at the brass, if it is liquid and has seeped away, fill up the riser with liquid brass. If the iron melts the brass quickly enough to enter the brass riser, plug the latter with a core until the iron is set.

Fluxes To Clean Solder

We are having difficulty with a flux for cleaning solder. We are using a mixture consisting of rosin, 5 pounds; salammoniac 5 pounds; charcoal powder, 5 pounds, and sulphur powder, 12 ounces. We mix this flux and after the solder has melted and has reached a temperature of 450 degrees Fahr. we put in 6 or 7 small ladles of the flux. We then work the bath for about 15 minutes, running the temperature up to 550 degrees until the mixture cakes, then we skim carefully. We ought to be able to commence dipping the metal out when it reaches 510 degrees, but are unable to do this on account of the accumulation of heavy metal under the surface of the solder. This latter is not a powder, but a heavy, white metal. We use brass for dipping. We would like to be informed why this dross or foreign enemy of the solder is not worked out.

The difficulty is caused by the incorporation of sulphur in the flux. We suggest the sulphur be eliminated, the salammoniac reduced at least 50 per cent and the rosin increased. After the metals are melted a little of the reconstructed flux should be added and the bath of solder should be thoroughly stirred for a considerable period, the longer the stirring the better mixed will be the solder. In dipping brass, some of the metal is dissolved with the result that copper and zinc enter the solder. The copper causes a thickening of the solder and when this occurs the old flux with sulphur should be used to clean the bath. The sulphur will combine with the copper, and this will produce some thick metal which should be removed, for refining. The salammoniac will act favorably on the zinc, with the result that the metals which harm the solder are largely removed. Unless the bath has become thick after a lot of brass has been dipped, it will do harm to use sulphur as the latter will combine with the metals composing the solder to the detriment of the latter.

Self Lubricating Bearings

We have orders for special bearing bronze that must be used in a position where it cannot be lubricated. The bearings will operate against highly finished commercial machine steel, at a maximum speed of 200 revolutions per minute. The pressure on the bearing will be approximately 50 pounds per square inch. The conditions not being severe, with the exception of lack of lubrication, we thought that an alloy of copper, 80 per cent; tin, 10 per cent, and lead, 10 per cent, might meet the requirements. Please let us have your opinion in regard to this matter.

The alloy mentioned is a good ordinary bearing metal, but whether it will run cool under the circumstances is doubtful. There are so many different and ingenious methods of lubricating moving machine surfaces that it ought to be feasible to supply lubrication to the bearing mentioned. Possibly a more highly leaded alloy would be superior to the 80-10-10 alloy. You might try an alloy of copper, 77 per cent; tin, 8 per cent; lead, 15 per cent. Melt the copper, add the tin and then the lead. The result is an excellent bearing alloy.

Tough Brass Alloys

We would like to obtain the formula for a strong alloy suitable for use at temperatures around 650 degrees. The castings are simply rings.

The following alloy will be quite suitable for the purpose outlined. Copper, 90 per cent; tin, 5 per cent, and phosphor tin, 5 per cent. The grade of phosphor tin containing 5 per cent phosphorous should be used.

Measuring the Temperature of Steel

The Use of Thermo Couples, Radiation and Optical Pyrometers in Measuring the Temperature of Molten Steel Is Considered—How the Rod, Film and Pouring Tests Are Employed

BY F. W. BROOKE

A LARGE number of trials and experiments have been carried out by steelmakers along with the commendable support of the makers of pyrometers to try and place the measurement of molten steel upon a scientific and fairly reliable basis. Most of the practical investigators have known that the measurements of actual temperatures to any degree of accuracy at present is impossible and have contented themselves with the results of comparative tests.

The thermocouple for temperatures of heat treatment has proved valuable. In the measurement of molten steel, however, only the rare metal couples can be considered, and even these do not withstand the severe conditions of such a bath. The mechanical strength of a long tube at the high temperature is inadequate; the chemical reaction of the slag in the case of basic operation is undesirable; and the varying thickness of the coating of slag to the tube as it is pushed through causes a varying lag of temperature from the steel to the couple.

Radiation Pyrometers

The radiation pyrometers require no focusing and the method of handling them is simple. These instruments have an attachment for taking care of the change in black body conditions from true black body conditions when steel is poured from a furnace or from a ladle. The first obvious objection to the use of this instrument is that owing to the slag covering in the furnace, the temperature cannot be read until the steel is being poured from the ladle. This only allows for correction of temperature in one direction. If the temperature of the steel is too low, preference can be given to the heavy castings of large section. If the temperature is on the high side the steel can be left in the ladle, or preference given to all the small castings requiring a relatively high temperature; but perhaps the greatest value is a check and guidance for the melter and foundry superintendent on the more or less crude practical methods now existing. The principal objection to the use of radiation pyrometers lies in the difficulty of focusing through a clear atmosphere and on a clean stream of steel. In actual practice it is found that smoke and incandescent gas are constantly interfering with accurate reading. In many furnaces the slag comes out of the teeming spout along with the steel and it is difficult to know which of the readings recorded represents true conditions. There is also the tendency on the part of the observer to record the highest reading on the instrument and interference of a small amount of incandescent gas can escape notice. The following readings are typical of many tests made of a stream of steel leaving the nozzle of a ladle when pouring castings of easy section of about 30 to 100 pounds in weight and 0.25 to 0.35 per cent carbon, by the same instrument and same observer, the resulting castings being of first class quality:

Heat No. 7			Heat No. 23		
Mold	Degrees Cent.	Degrees Fahr.	Mold	Degrees Cent.	Degrees Fahr.
1	1510	2750	1	1530	2790
2	1560	2840	2	1540	2800
3	1515	2760	3	1210	2210
4	1740	3170	4	1560	2840
5	1530	2790	5	1490	2710

It is obvious that the readings on the fourth mold of heat No. 7 and the third mold on heat No. 23 were decidedly off although every care was taken on both these heats to get uniform conditions and the error is undoubtedly due to incadescent gas and smoky atmosphere.

Optical pyrometers are subject to the same limitations as those of the fixed focus radiation type. They are not so liable to damage by the too close proximity of the molten metal as an observer has less fear of sticking a long tube up to the stream than of bringing his face too near.

Among the practical methods known, the film, rod and pouring tests are in constant use at various steel plants. The use of the film test originated from the crucible steel practice. Before drawing the pots containing alloy tool steel, all the melting shop doors were closed, then the pots were pulled after the required stewing and the lids and slag were removed. Alloy additions were made and then the bright surface of the steel carefully watched for the first sign of an oxide film forming, this being regarded as the sign to commence pouring the metal.

In electric furnace practice the film test is carried out by using a steel spoon of uniform capacity, dried out thoroughly over the bath and giving this a total covering of slag in the furnace. A sample of steel should then be taken, which fairly represents the whole bath, remembering that when a door has been left open for some time the steel near the door has become chilled. With steel made in an electric furnace where all the heat is applied at the top only, the temperature of the steel directly under the slag is higher than the temperature of the steel near the bottom. Where this is the case the bath must be thoroughly rabbled before any sample is withdrawn, and even then the sample should be taken from a point equidistant between the electrodes and half way down the bath, so as to arrive at a fair average temperature. The measurement of the temperature is indicated by the length of time it takes for an oxide film to form completely over the sample.

Film Test Varies

Final comparisons must only be made between steels of approximately the same composition and when the furnace is ready to pour. Care must be taken to keep the sample away from drafts and to have about the same amount of steel in the spoon each time. To show the range of this test it has been noted that first class high-speed steel ingots of a composition approximating carbon 0.65 per cent; tungsten, 17.5 per cent; chromium, 3.75 per cent, and vanadium 1.00 per cent were produced when the film (with a later characteristic wrinkling of the surface) was formed directly the sample spoon came through the door; while good castings of about 0.25 per cent carbon and weighing from 30 to 100 pounds were produced when the film took 60 seconds to form after passing through the furnace door.

The rod test has been used for many years to get a rough indication of the temperatures of many molten metals. This test requires the use of steel rods of uniform diameter and fairly uniform composition. The test consists in plunging the rod into the bath of steel for a uniform length of time. If the steel is cold a deposit of the bath forms on the rod, while if the steel is hot

Abstract from a paper presented at the Philadelphia convention of the American Foundrymen's association. The author, F. W. Brooke, is with the Electric Furnace Construction Co., Philadelphia.

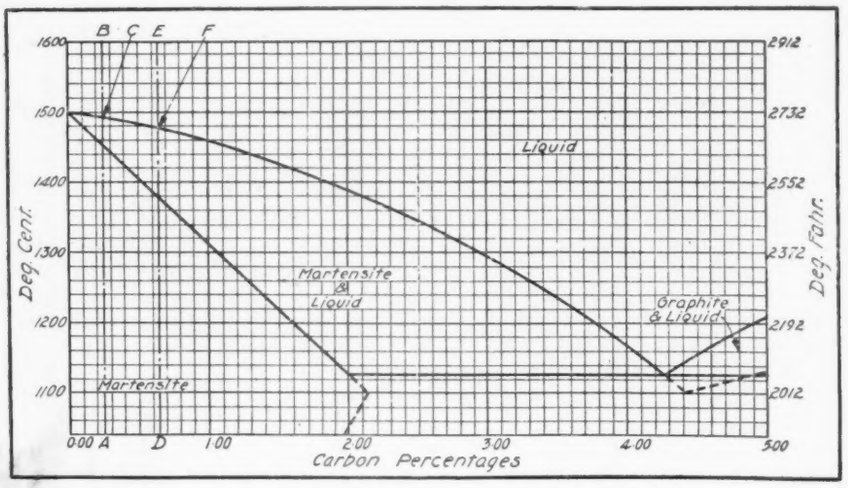
the bath melts away or bites into some of the rod; with all the intermediate conditions indicating varying temperatures. The skin of the bar, it will be noted, has an effect on this test; a newly rolled bar with a bright scaly surface tends to show a colder bath than is actually the case. The bar should be of a uniform temperature before being plunged into the bath and in some steel works this is taken care of by bending about 12 inches or more of the end of the bar at right angles; holding the bar with the bend in a horizontal plane over the bath until it shows the first signs of sagging and then turning the end of the bar into the bath.

The pouring test consists of using a spherical spoon of above five inches diameter and carefully slagging up this spoon over the bath. Dip the spoon quickly into the metal so as to get a sample of the steel from about the center of the bath. Withdraw the sample and pour the steel over the lip of the ladle at a slow even rate. The temperature of the steel is noted by its fluidity, and by the amount of steel skull left in the spoon. This test is the one most commonly used among the steel foundries.

For all these practical methods too much emphasis cannot be laid on the fact that they are all comparative tests only and that they depend entirely upon uniform conditions and attention to details. In all cases at least two of these methods should be employed. They do not indicate to the melter the temperature of the steel in degrees Cent. or Fahr. but they do give him a good indication of the degrees of temperature that the steel is above or below the temperature which will give him the best results for the composition of the steel he is handling in relation to the weight and type of casting he is making.

In steel works where the best conditions for the pyrometer can be obtained, there is still the limitations of the instruments themselves. Only the optical and radiation offer a good field for these high temperatures and conditions, and there is little doubt that an error of plus and minus 50 degrees Fahr. in the instrument itself is all that we can ever expect.

The best temperature at which the steel should leave the furnace is that at which the particular steel begins to solidify, plus the loss of temperature from the time the reading is taken to the time when the steel gets to the farthest end of the thinnest section of the casting. It may be asked how are we going to know what these two values are? The first value depends on the composition of the steel, the carbon content being the principal factor. This can be obtained by reference to a standard carbon iron curve like that shown in the accompanying illustration. For a steel containing 0.25 per cent carbon trace the line *A B* until it intersects at *C* giving a value on this curve of 1492 degrees Cent. (2720 Fahr.); for a steel containing 0.65 per cent carbon trace the line *D E* until it intersects at *F* giving a value of 1476 degrees Cent. (2690 degrees Fahr.), and so on. For other elements commonly used in the steel for castings the variations are not of importance and do not compare with the many other sources of error that crop up in reading the temperatures of molten steel in a foundry. The second value depends upon such variables as the heat of the ladle, the thickness of ladle lining, time of reading to pouring, whether molds are of dry or green sand, and surface area of the thinnest sections. All of these factors depend very much on local conditions and constant consultation between the man responsible for steel in the furnace and the man responsible for making up the molds is necessary to get results.



STANDARD CARBON-TEMPERATURE CURVE FOR STEEL

Rolling Type Electric Furnaces Installed

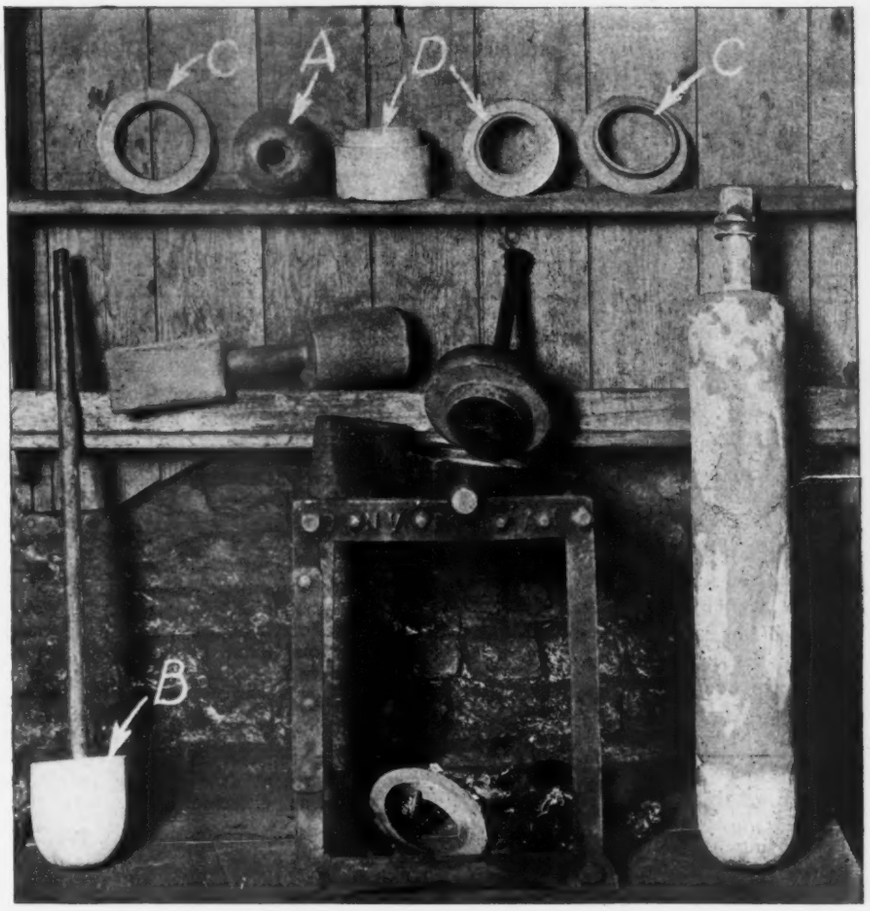
THREE installations of electric arc furnaces recently made in foundries in the state of Washington embody a number of novel features, each of which was demanded by the conditions obtaining in the plant. The unit shown in the accompanying illustration, which is employed by the Vulcan Mfg. Co., Seattle, has a capacity of two tons and is rated at 500 kilowatts. It is of the rolling cylinder type and the charging door is in the end, an arrangement which permits the furnace to set close to the transformer room, therefore occupying an unusually small amount of floor space. The tilting of the furnace is controlled by a 4-way hydraulic valve, shown at the right, which is said to be quick, direct acting and of simple operation. The furnace shell is provided with a dial and pointer to indicate the degree of tilting. This assists the operator in bringing the furnace back to its normal vertical position without shock.

A 500-kilowatt, 2-ton, rolling-cylinder type furnace recently was installed at the plant of the Lamb Machine Co., Hoquiam, Wash. The charging door of this unit is in the cylindrical wall of the shell opposite the spout. The furnace foundation is sufficiently elevated above the main floor of the foundry so that workmen may carry hand ladles away from the furnace without stooping over to pick them up. The ladles are supported by a ladle hanger while the metal is being tapped and workmen therefore may remain at a safe distance until the furnace is rotated to its normal position. When the metal is tapped into crane ladles, the shank ladle hanger is quickly removed. As in the case of the furnace at the plant of the Vulcan Mfg. Co., the tilting is controlled by a hydraulic valve situated at a convenient point safely removed from the danger zone.

The third furnace, which is in the plant of the Malleable Steel & Iron Co., Tacoma, Wash, is rated at 300

kilowatts and is adapted to making special grades of gray iron and semi-steel. Special castings heretofore unattainable on the Pacific coast are being produced at this plant. A second furnace will be installed, and when it is in operation, one unit will be employed for steel and the other for cast iron.

It is claimed that the roofs of these furnaces are of extremely simple design, standard shapes of silica brick being utilized except where the electrodes enter. The charging door shown in the accompanying illustration is operated by a hydraulic cylinder of the double acting type, which enables the operator to stop the door at any desired point. The furnaces were built and installed by the Greene Electric Furnace Co., Seattle.



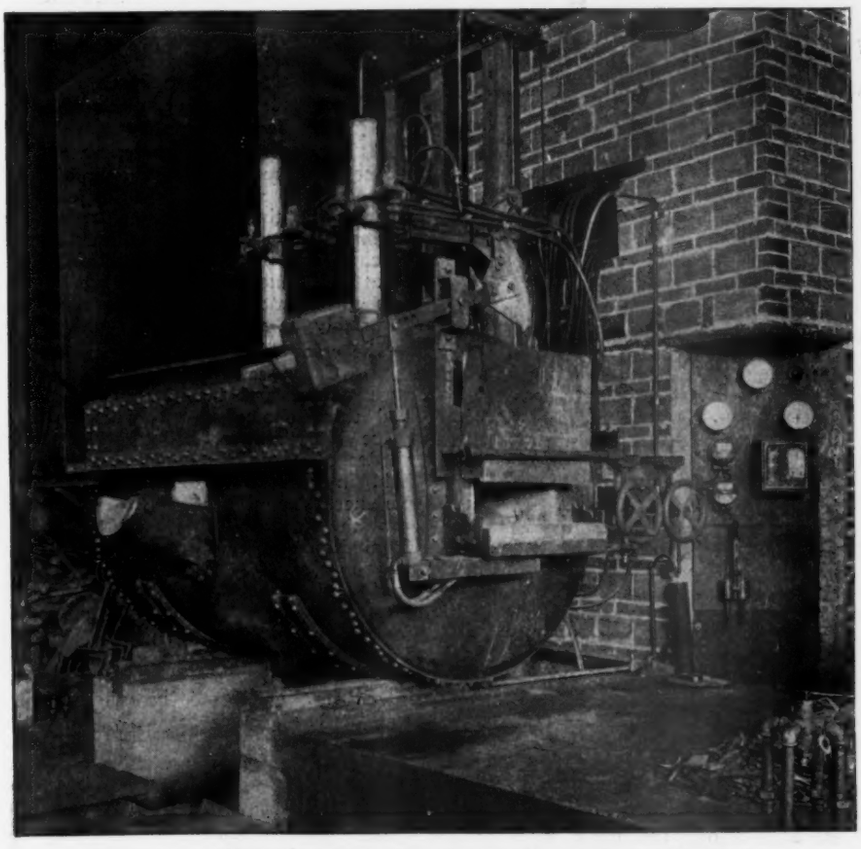
PARTS FOR A LADLE STOPPER INCLUDING A MOLD FOR MAKING THE CAST-IRON SUPPORTING RINGS FOR THE NOZZLE

Make Ladle Nozzles in the Core Room

Bottom pour ladles are commonly used in steel foundries but iron foundries almost invariably pour the metal over the lip of the ladle. In a few cases where it is essential to have clean castings and where the cast ings to be poured are not too small, bottom pour ladles are also used in the gray-iron foundry. A number of shops making car wheels use them exclusively. This class of work lends itself readily to the bottom pour ladle because the amount of metal to be poured on each floor usually is the same during the entire day and it must be poured rapidly. Ladles for this purpose have a capacity of about 1000 pounds and require only a short stopper, which can be made in a much more simple manner than a stopper to be used in a steel ladle, as the latter must hold a far larger amount of metal several hundred degrees hotter than the pouring temperature of gray iron. Should the steel ladle leak, or the stopper fail altogether, the consequences might be serious, but with only 1000 pounds of gray iron in the ladle a leaky ladle seldom would cause much trouble.

For this reason more chances may be taken in making up the stopper in the gray-iron foundry, and some things can be done which would not be practical in a steel foundry. One of these is to make the nozzle in the core room. The different sections which make up a stopper and nozzle for a bottom-pour ladle of 1000 pounds capacity used in the foundry of the Griffin Wheel Co., Chicago, are shown in the accompanying illustration. To make the stopper rod the plumbago stopper

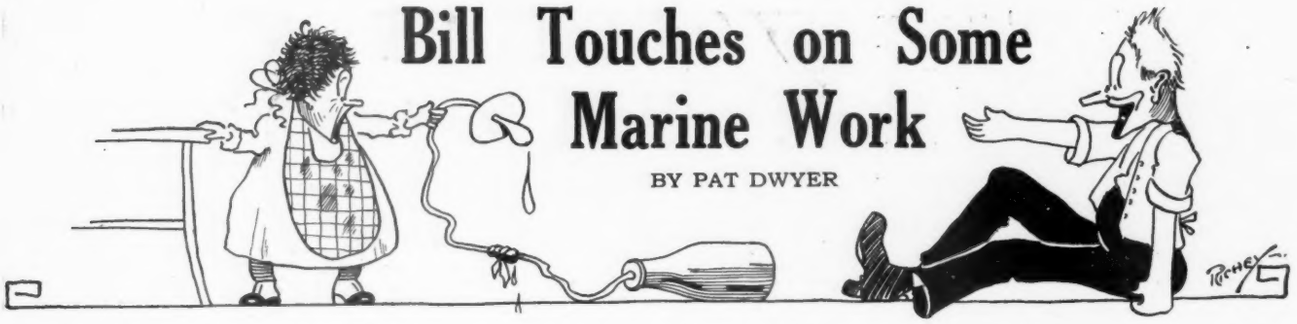
(*Concluded on page 205*)



TWO-TON, 500-KILOWATT ROLLING TYPE FURNACE INSTALLED IN SEATTLE PLANT

Bill Touches on Some Marine Work

BY PAT DWYER



DROPPING into Bill's house the other night I found him sitting on the floor teaching a young cherub about a year old how to walk. I advanced the opinion that children should not be forced to walk so early in life as it probably would cause them to have bandy legs and in this specific instance I warned him that when the young lady grew up she would not cherish the same feeling of love, esteem and admiration for her father as she would if her limbs were like the Venus de Milo.

"Nothing in that theory," said he. "If there was, every bandy legged molder in the country would attribute his pair of brackets to the error of judgment on the part of his parents in making him walk at a tender age. As a matter of fact, it is universally recognized that bow legs on molders are caused by carrying heavy dinner pails to work and by carrying heavy ladles of iron out to the dog house every afternoon. I worked down in Monterey one time and the man next to me had the bandiest pair of legs I ever saw on a human being. They looked like the front supports of a prize bull dog. His mind had a peculiar bend in it too. I went up to his house one night on a visit and he told me of a shop he at one time had charge of in the central west. It appeared that he had made such a success of it that he was regarded as an oracle. His opinion and advice were sought by foundrymen for miles around. A most extraordinary request came to him through the mail one day from a foundryman in a neighboring state. He showed me copies of the question and his reply, and in case it may tax your credulity I can show you a copy of the correspondence which he very kindly forwarded to me some time after I had left there on a tour up the coast."

Bill called to one of his numerous young lady relations and asked her to bring him the book in which the document was folded and put away. She brought it and Bill turned over the leaves until he found the desired paper.

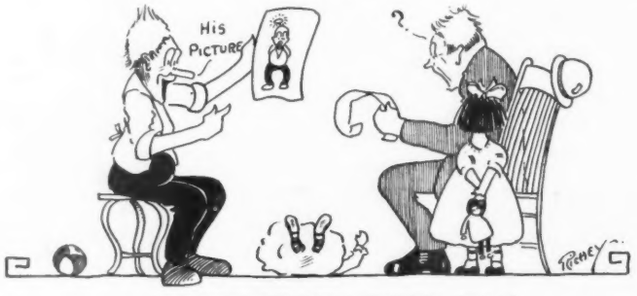
"Here," said he. "Just look over that and see what you think of it."

It was in the shape of a question and answer and was as follows:

We have been asked to quote on a quantity of king-post castings for submarines. This is a little out of our regular line, which is mining machinery for wild-cat mines, and we will appreciate any information you can give us on the most efficient method of molding these castings, also a suitable mixture to pour them.

The answer the bird sent them was both complete and voluminous. He said:

Replying to your esteemed communication of recent date we beg to advise that it was extremely fortunate that you thought of consulting us before undertaking such a hazardous enterprise. The contemplated line of castings is one of the most difficult with which foundrymen have to contend.



HE WAS THE ORIGINAL FOUNDRY ORACLE

There is a certain amount of similarity between the proposed work and that in which you are already engaged. Submarines are only seen occasionally and wild-cat mines are never seen. In point of seniority the wild-cat mining industry admittedly is in the lead. It has been in existence since the golden days of '49, while the submarine has only been a recognized factor in industrial life during the past decade.

Wild-cat mining machinery has been brought to a high state of development in this country and some large and complete units have been set up in various rich mining sections of the country, notably New York, Chicago and Boston. The veins in these districts have been worked for years, but the supply of rich auriferous ore seems to be inexhaustible.

We will now consider some of the features necessary to the successful production of king-post castings for submarines. The selection of a grade of sand suitable for castings of this description is of the utmost importance. It should conform to the strictest chemical and physical specifications. The slightest deviation from the accepted standard will play havoc with the completed casting. When it is realized that the king-post is the center on which the submarine pivots it will be apparent to any thinking person that the slightest variation in the metal thickness, or in the specific gravity of the iron of which the casting is composed will have an appreciable effect on the boat's evolutions. It also must be borne in mind, that the boat is destined primarily to operate and function under water and that the pressure increases in direct ratio to the depth and therefore the iron must be of a suitable analysis to resist hydrostatic pressure. The corrosive action of sea-water, profanity at close quarters, and the line of conversation handed out by the First Luff also must be taken into consideration. These are points which will be touched upon again when we consider the tests to be employed in selecting a suitable iron mixture for pouring the castings. A grade of light sand should be selected for making the molds. By light sand is meant one which when weighed at ordinary atmospheric pressure and temperature, on a standard beam or platform scale will register approximately 16 ounces to the pound, avoirdupois. If it is desired to prepare a large quantity at one time, say a ton, it will be deemed to come within the limits of this specification if each ton contains 2000 pounds. Sand not measuring up to this specification or exceeding it should invariably be rejected.

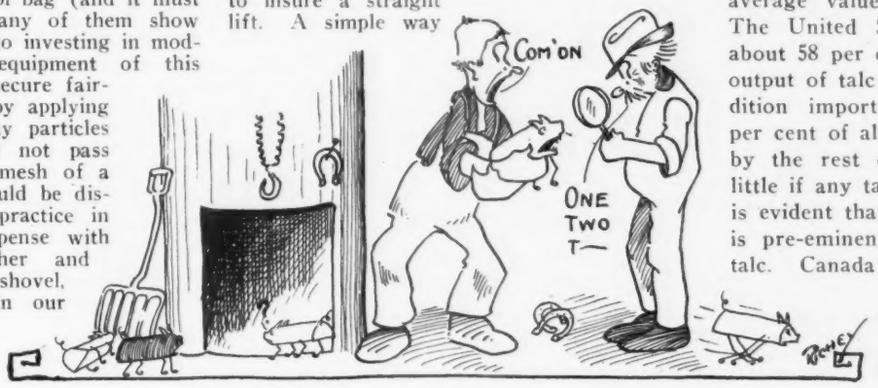
The color of the sand is an important item. Green sand is the most suitable with yellow and black sand as second and third choice in the order named. Alice blue, mauve, heliotrope or vivid shades of vermillion and scarlet are not held in repute by foundrymen of experience. Some time ago the "Society for the Extraction of Square Pegs from Round Holes" recommended that ultra-marine blue sand should be used exclusively on marine work but the measure did not meet with approval. It was held that while the prospects for the American merchant marine did not look blue that was no reason for introducing blue sand into the molding shop. The committee to which the question was referred also reported that blue had a depressing effect on the men's spirits. It is a notorious fact that the output on blue Monday always falls short of that turned out on any other day of the week, due to color effects.

Irrespective of its color, the sand must have a high coefficient of expansion and contraction, which means that it must not be so tight that it will squeak while the rammer is going through it and at the same time it must not be of such an open texture that the molten iron will seep through it during the pouring operation, and run out through the bottom board. A microscopic examination should disclose grains of a uniform size, slightly angular in contour and lying in reasonably close proximity to each other. If the molder has no microscope in his tool bag (and it must be admitted that many of them show a decided antipathy to investing in modern and efficient equipment of this character) he may secure fairly accurate results by applying the riddle test. Any particles of sand that will not pass freely through the mesh of a half inch riddle should be discarded. It is the practice in some places to dispense with the riddle altogether and simply use a fine shovel, but this method, in our opinion, is not sufficiently accurate and should be discouraged. It tends to retard production when the molder has to dig pieces of coke, scrap and sometimes gaggers out of the face of his mold after he has drawn his pattern.

Other characteristics of molding sand which must be taken into consideration are: Elasticity, elongation, reduction in area, and the ability to withstand tortional and compression strains. A sand with a high elastic limit should not be used, for two reasons: First, because it cannot be packed tightly, and, second, because it is a menace to the life and limbs of the operator. A man using a pneumatic rammer on this kind of sand is in danger of having his knee-caps knocked off by the rebound of the rammer.

Elongation also is to be avoided. This feature in molding sand forces the ends of the slip jackets apart and causes distorted castings. Reduction in area also is dangerous. This peculiar characteristic of some sands causes a great many disputes between the molders and the clerk who takes up the heat. The clerk counts the number of molds on the floor and credits the molder with, say, 100. The next day there are only 95 castings to be found, a phenomenon which is clearly produced by the excessive reduction in area of the sand. The sand in the molds shrunk 5 per cent between the time the heat was taken up and the time the castings were poured.

The habit which some molders have of attaching chains to their flasks and giving the crane-man the high sign before the chain block is centered over the load has a tendency to place a severe strain on the sand in the mold and it is therefore necessary to provide a sand which will resist this tortional and compression strain. In the event that such a high grade sand is not available, ordinary sand may be used provided suitable precautions are taken to insure a straight lift. A simple way of doing this is as follows: A straight line is projected diagonally across from opposite corners of the flask with the aid of a surveyor's transit or theodolite, and the point where the lines cross is marked with a stake. A perpendicular is erected from this stake using the formula laid down by Q. E. D. Euclid for that purpose. The crane is then summoned and the operator requested to lower his hook and manipulate his bridge and rack until the exact center of the hook coincides with the perpendicular.



TEETH ARE THE SURE GUIDE TO A PIG'S AGE

The importance of selecting the proper kind of iron for these castings cannot be emphasized too highly. The best iron for the purpose is one that has been made from ore which has been extracted from submarine areas. We should advise the following mixture: 30 per cent old pig; 30 per cent young pig; 30 per cent mixed foreign and domestic scrap, and 10 per cent horseshoes. The old pig furnishes the strength and toughness. The young pig makes the metal run readily. The domestic scrap is used so that the board of directors cannot see a pile of it on their tour of inspection and thereby draw inferences. The foreign scrap is used because of the well known psychological fact that far-away cows have long horns, and the horse shoes, it is unnecessary to point out, are added for luck.

"You must have met some queer people in your time," I said. "I wonder if you ever bumped into the Baron Munchausen?"

"I don't recall any fellow by that name," said he, "but I knew a bird in Birmingham, Alabama, one time—

"Never mind his name," I said. "I have heard all the birdie stories I want to for one night."

ALL THE BARON LACKED WAS BILL'S FOUNDRY EDUCATION

United States Leads in Talc Production

America leads the world in the talc industry, not only in production but especially in manufacture and use. The output of talc in the United States sold in 1918, according to J. S. Diller, of the United States geological survey, department of the interior, was 191,477 short tons, having an average value of $10.91 a ton. The United States produced about 58 per cent of the world's output of talc in 1918 and in addition imported more than 11 per cent of all the talc produced by the rest of the world. As little if any talc was exported, it is evident that the United States is pre-eminently a consumer of talc. Canada is the only competitor for the domestic trade in middle-grade talc. About 12,000 tons, 96 per cent of the talc imported in 1918, came into the United States from Canada.

The United States is well supplied with low and middle grade talc but lacks high-grade material, which is imported mainly from Italy and France and through other countries from India.

Within the last two years a new and interesting source of talc has been found in Harford county, Md.

The Buckeye Casting Company, Lima, Ohio, is installing new equipment to increase its capacity to 400 tons a month. The new equipment includes a No. 3 Whiting cupola, compressor for elevator, air tools, sand blast, tumbling barrels, molding machines, etc. John Sonnenfeld is president, with Carl B. Limbert as vice president and Lou P. Stephens as secretary and treasurer. A steel foundry with electric furnaces is under contemplation.

THE FOUNDRY

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Cupolas Deserve Attention

THE cupola is a comparatively simple melting medium and one soon learns to operate it in a fashion, getting results which are accepted generally as satisfactory. One of the requirements of the foreman of the cupola department is to handle laborers, and this frequently is the main consideration in picking the man to have charge of the cupola. Of course it is important that a man in such a position should be able to handle labor, but he also should have enough education to be able to appreciate the points necessary to operate the cupola efficiently. If a foreman cannot be found who has both practical knowledge of melting and the ability to handle men it is advisable to secure two men and place one in direct charge of the laborers and let the other supervise charging and watch the iron as it is tapped and poured. The latter should have at least a high school education and should receive instructions from the company's metallurgist, so that he will know the reasons for the different reactions in the cupola and what causes different effects in the metal. Such a man will be of little service at first, but in a short time he will show a savings for his employer. Trained intelligence used about the cupola soon will improve the charging and melting practice in most plants. Some large companies which have several foundries adopt the plan of employing high school graduates to supervise the cupolas and the head metallurgist issues bulletins that direct them in their work, instruct them concerning details of operation and point out the meaning of different results.

Castings Indispensable

PRACTICALLY all modern human activity is based upon the products of metal working plants. This statement may be passed as trite through frequent repetition, but it is doubtful if its full truth is realized even by those who are engaged in the foundry, forge or machine shop. In Belgium and portions of France much of the territory occupied by the invading German was reduced to a state bordering on the primeval. Factories were stripped, homes leveled and even the productive soil was swept bare of all which represents the life and activity of man. Repatriation in many regions meant a building up from bare foundations, and a creation out of elemental materials. The inhabitants had been scattered widely through the years of war, and many, blown by the wind of chance, had taken root elsewhere and were not attracted by the bleak prospect of returning to the devasted area. It is significant of the fundamental necessity of foundry products, that in many cases casting plants were the first to be rehabilitated. Homes, factories, transportation equipment, tools, machinery and agricultural implements, all urgently needed foundry products. Even before those who had been exiled began to find their way back again to that portion of the country which had been home, work was actively under way to rebuild, equip and provide materials for the foundries of northern France and Belgium. A most interesting account of the re-establishment of one large industrial concern is presented in the first article of this issue. The restoration of this plant is typical of many throughout the occupied territory.

Trade Outlook in the Foundry Industry

DEMAND for castings which has steadily increased during the past few months now has become acute. Manufacturers driven by urgent and immediate needs are writing inquiries broadcast or sending agents to foundries remote from their territory in the endeavor to secure enough castings to keep their plants in operation. This situation is most marked in gray-iron and malleable lines. The approach of spring has brought an unprecedented flood of construction work, which the public insists upon in entire disregard of the peak prices asked for all classes of building materials. Manufacturers of plumbing and heating supplies are overwhelmed with orders. One large maker of bathroom and heating equipment has advance orders for over 200,000 bath tubs, which will tax the capacity of the company's several plants for the entire year. Automobile manufacturers instead of canceling contracts for castings, a procedure which was predicted by some foundrymen in the early winter, are doubling their orders where possible and seeking untried sources for practically all grades of castings used in making trucks, passenger cars and tractors. Agricultural implement makers are experiencing an unprecedented activity and state that this marks the opening of the largest year ever known in the manufacture of all kinds of farm machinery. Those who supply castings for what might be termed luxuries or more correctly nonessentials are unable to take up any of the overflow demand from other lines. Makers of piano plate, builders of soda fountaln equipment and manufacturers of confectioners' machinery are seeking additional foundry capacity to make urgently needed castings.

Prices of Raw Materials for Foundry Use

CORRECTED TO FEB. 23

Iron		Scrap	
No. 2 foundry, Valley	$42.00 to 43.00	Heavy melting steel, Valley	$27.00 to 27.25
No. 2 foundry, Birmingham	40.00 to 41.00	Heavy melting steel, Pittsburgh	28.50 to 29.00
No. 2 foundry, Chicago	40.00 to 42.00	Heavy melting steel, Chicago	24.50 to 25.00
No. 2 foundry, Philadelphia	43.60 to 44.60	Stove plate, Chicago	35.50 to 36.00
Basic, Valley	43.00 to 44.00	No. 1 cast, Chicago	42.00 to 42.50
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	29.00 to 40.00
Malleable, Buffalo	41.25 to 42.25	No. 1 cast, Birmingham	33.00 to 35.00
		Car wheels, iron, Pittsburgh	44.00 to 45.00
Coke		Car wheels, iron, Chicago	37.50 to 38.00
Connellsville foundry coke	$7.00	Railroad malleable, Chicago	33.50 to 34.00
Wise county foundry coke	8.25	Agricultural malleable, Chicago	33:50 to 34.00

New Users of Castings

The marked increase in different makes of small motors, washing machines and other household machinery has brought a new class of small castings users into the market at a time when it is most difficult to find foundries which can supply the needed parts. With all this rush of business a marked extension in the entire foundry industry is in full swing. The abnormal demand has been accentuated by shortage and nonproductiveness of labor to a degree which threatens an over expansion. It is commonly understood that when a manufacturer places an order for a great number of castings upon which he can receive no assurance of time of delivery and little guarantee of price, he duplicates his order with a number of foundries. Then when his requirements are covered by the delivery of his order from one firm, he at once will cancel the pending orders with other foundries. There is a basis for the opinion held by some foundrymen that the present demand is inflated and that the rapid expansion of foundry facilities may eventually result in a general slackening off with the attendant reaction comparable to over production.

Rail Buying Expected

With the return of the railroads to private ownership, the long expected buying of equipment seems imminent. This will have a marked effect, both on those foundries which specialize on railway work and also indirectly upon others, through the withdrawal of some, notably malleable shops from the manufacture of miscellaneous castings to concentrate on railroad work. It is stated that a plan is nearing completion which will permit the early purchase of 2000 locomotives and about 100,000 freight cars to be allocated among the different railway lines. The roads have been gathering their own equipment, making lists of requirements and otherwise preparing to be early in the field in the rush for supplies which is expected to follow the return to private control. Car-wheel shops which for the past two years have been almost entirely inactive except for repair and replacement work, anticipate a heavy demand. The shortage due to meager replacements during the war, has been brought sharply to focus by the tremendous rush of business and attendant pressure on transportation agencies during the past few months. It is stated that the railroads normally require about 100,000 new freight cars every year to replace those which wear out in service. This figure is derived from the following table showing the purchase of cars by the railroads during the five years preceding the war:

	Added	Retired
1913	162,670	96,825
1914	150,813	96,985
1915	86,012	90,347
1916	88,254	109,996
1917	117,208	*62,250
Total	604 857	456,403
Average	120,991	91,284
Net addition yearly	29,700	.....

*Estimated.

Less Call For Iron

A slackening is noted in the demand for foundry iron. By some this is attributed to the realization of the lack of iron for early delivery and the wish to avoid bulling a market which already is considered too high. The slight recession in scrap prices is the result of a common agreement to disagree between the dealers and foundrymen. The latter feel that scrap prices are beyond reason. New York quotations on nonferrous metals follow: Copper, 18.25c; lead, 9.12½c; tin, 61.20c; antimony, 11.75c to 12.00c; aluminum, No. 12 alloy, producers' price, 31.50c and open market, 30.00c to 31.50c; zinc is 9.00c St. Louis.

Comings and Goings of Foundrymen

CHARLES A. DREISBACH, formerly president and manager of the New Haven Sand Blast Co., and Charles S. Johnson, formerly western representative of the same company, now are associated with the Standard Equipment Co., New Haven, Conn., manufacturer of cinder mills, ore crushers and pulverizers. The Standard Equipment Co. soon will enter upon the manufacture of a line of foundry equipment.

William Bragg has been made foundry foreman for the H. Wetter Mfg. Co., South Pittsburgh, Tenn.

Charles A. Bieder has been appointed assistant manager of sales in the railway department of the National Malleable Castings, Co., Cleveland.

L. D. Kluver has been placed in charge of the newly established Detroit office of White & Bro., Inc., Philadelphia producers of nonferrous alloy metals.

John D. Green, secretary of the Detroit Stove Works, Detroit, has resigned to become vice president and general manager of the Rathbone-Sard Co., Chicago, stove manufacturer.

B. L. Weaver has resigned his position as steel foundry superintendent for the Vulcan Iron Works, Wilkes-Barre, Pa., to become associated with the Philadelphia Roll & Machine Co. plant of the Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

F. J. Ryan was elected president of the Metallurgical Corp., Philadelphia, at the recent annual meeting. Other officers of the company are S. R. Vanderbeck, vice president; W. L. Taylor, treasurer; J. L. Hawley, assistant treasurer, and S. H. Ourbacker, secretary.

K. B. Thorndike has been appointed sales engineer in charge of the New York office of the Phoenix Iron Works Co., Meadville, Pa. A new Boston office has been established by the same company with Paul C. Rogers in charge.

T. A. Martin recently has severed his connection with the George H. Smith Steel Castings Co., Milwaukee, and now is in charge of the installation of a new steel foundry for the Erie Forge Co., Erie, Pa.

William R. Gummere, who for a number of years was associated with the Independent Pneumatic Tool Co., Chicago, again has joined that company and will be connected with the Pittsburgh branch office.

Paul V. Faragher, formerly connected with the Mellon institute at Pittsburgh, has accepted a position in the research laboratory of the Aluminum Steel Co. of America, New Kensington, Pa.

John H. Rose has been appointed sales engineer of the Aetna Foundry & Machine Co., Warren, O. Mr. Rose since 1912 has been associated with the Youngstown Sheet & Tube Co. in the engineering department.

H. P. Wingert, formerly general purchasing agent for the American Brake Shoe & Foundry Co., now is president of the American Commodities Corp., organized to handle pig iron, coke, coal, iron and steel products, and scrap. The offices of the new company are at 30 Church street, New York.

D. C. Jones, Lunkenheimer Co., was elected president of the Associated Foundries of Cincinnati at a recent meeting. The other officers chosen were Neil C. Lamont, Worthington Pump & Machinery Corp., vice president; George F. Dana, Peerless Foundry, secretary; and H. A. Lammers, Cincinnati Steel Castings Co., treasurer.

W. E. Troutman, president, and R. W. Tener, treasurer of the Braddock Mfg. Co., Braddock, Pa., retired recently coincident with the sale of that company's plant to the Wilson-Snyder Mfg. Co., Pittsburgh. F. C. Sullivan, vice president and engineer, also retired on March 1, while H. L. Campbell and F. B. McConnell, other officers of the company remain with the new owners. The Wilson-Snyder Co. manufactures pumps and equipment.

M. F. Gartland was elected first vice president of the Dayton Malleable Iron Co., Dayton, O., at its recent reorganization meeting, which re-elected J. C. Haswell president. Mr. Haswell closed his annual report with a tribute to the late Samuel W. Davies, who was connected with the company for more than 30 years, recently as vice president. Other officers elected at the meeting are: Vice president in charge of sales, H. D. Hunter; vice president in charge of operation, W. B. Runyan; secretary, W. H. Cassel; treasurer, Adolph Heinz.

Col. John Roper Wright has received a baronetcy at the hands of the king of England. Most of his achievements have been in connection with the steel trade, largely in South Wales. He commenced his career in Soho Foundry, Preston, and as a young man on the staff of the late Sir William Siemens carried out all of the experiments for the manufacture of open-hearth steel by the Siemens-Martin process. Subsequently he went to Swansea and developed the process commercially. After being associated with several steel companies an amalgamation was effected in 1894 of E. P. & W. Baldwin of Stourport, Wright, Butler & Co., Alfred Baldwin & Co., and the Blackwall Galvanizing Co. into Baldwin's, Ltd. Since 1908 Colonel Wright has been chairman of the latter company having succeeded the late Alfred Baldwin. Colonel Wright is a director of several other companies.

Traces History of Iron

Dr. John G. Unger, head of the bureau of research of the United States Steel Corp., was the chief speaker of the regular monthly meeting of the Pittsburgh Foundrymen's association. Dr. Unger substituted for Louis E. Endsley, professor of mechanical engineering, University of Pittsburgh, who was to have been the principal speaker, but who was unable to be present on account of illness.

The speaker claimed that the discovery of iron outdated that of either gold or silver, asserting that authority existed for the belief that Enoch, son of Cain and grandson of Adam, actually discovered iron in the ashes of the smoldering camp fires along the banks of the Euphrates river. Dr. Unger traced the history of iron, both from a geological and chemical standpoint, and ventured the prediction that not only would the country soon be using ore of much lower metallic content than that now used, but that within 100 years, iron would be supplanted by some alloy derived from clay, containing iron, silica and alumina, which he said would be a third the weight of iron and possess higher physical properties than iron.

Montfort Jones, professor of economics, University of Pittsburgh, gave a talk on the foreign exchange situation, in which he pointed out the dangers to foreign trade unless the present rates were soon adjusted and also the possibility of the reshipment of American products to this country because of the big premium which the American dollar now commands in international exchange.

New Truck For Foundries

A new gasoline truck for hauling castings, cores, molds, sand, and other burdens up to 2500 pounds weight has been placed on the market by the Clark Tructractor Co., Chicago, Ill. This machine is designed to operate inside the plant buildings as well as outdoors, at speeds varying from ½ to 12 miles per hour. It is narrow in construction and so will run in aisles and within a very limited operating space. It acts as both a truck and tractor. Foundries use this machine in the core room, stock rooms, sand piles and for general plant haulage. Bodies of various types are furnished for carrying the load. All bodies will carry a 1¼-ton load and cargo bodies have a capacity of one cubic yard of bulk materials such as sand, etc. A truck unloading sand is shown in the accompanying illustration. The machine is run on three wheels, and is steered from the rear by a single wheel. The load is carried over the two front driving wheels. The driver's seat is over the engine facing the load. The four-cylinder engine is carried above the single rear wheel.

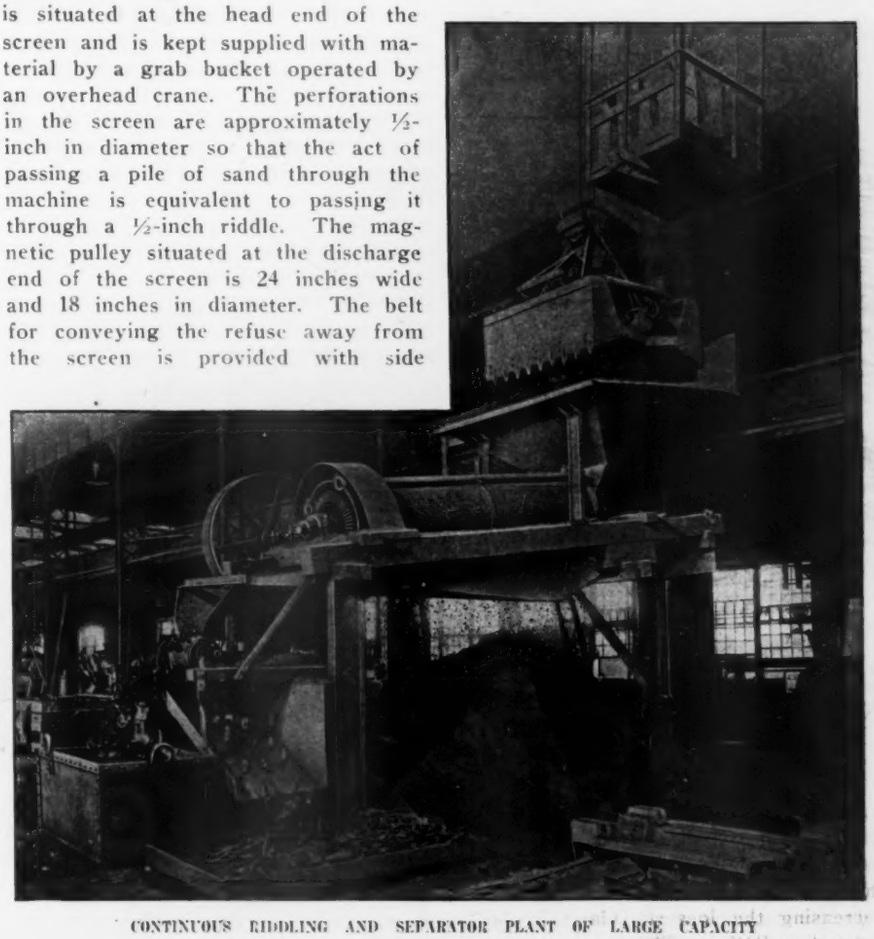
NEW TYPE COMBINED TRACTOR AND TRUCK FOR FOUNDRIES

Combined Sand Mixer and Magnetic Separator

An installation, designed and built by the Dings Magnetic Separator Co., Milwaukee, is shown in the accompanying illustration. The equipment which includes a sand mixing and riddling system with a magnetic separator, is strong and ruggedly constructed. It is mounted on a platform at a sufficient height from the floor to allow the screened sand to be piled at a point on the floor from which it can be removed by barrow or grab bucket. The box or other receptacle for catching the refuse is also located on the floor level. It usually is provided with handles by which it can be lifted by the crane and conveyed to a car or truck employed for transporting that kind of material to the dump.

By referring to the illustration it will be noted that the complete machine consists of a feed hopper, a large revolving screen and a magnetic pulley with suitable motor, pulleys and belting to drive it. The feed hopper which has a capacity of 3 or 4 yards is situated at the head end of the screen and is kept supplied with material by a grab bucket operated by an overhead crane. The perforations in the screen are approximately ½-inch in diameter so that the act of passing a pile of sand through the machine is equivalent to passing it through a ½-inch riddle. The magnetic pulley situated at the discharge end of the screen is 24 inches wide and 18 inches in diameter. The belt for conveying the refuse away from the screen is provided with side boards and deflection boards to prevent any of this material from falling upon the lower belt which is shown in the illustration.

Under the ordinary system of cutting over sand either by hand or mechanically, none of the foreign material is removed unless it happens to be quite large and cannot be ignored. It is claimed for the magnetic separator that it screens all of the sand and leaves it in condition for molding purposes; that it eliminates all the coarser material and while this latter is passing over the magnetic pulley it reclaims all the iron which may have found its way into the sand during the day. Clamps, gaggers wire, rods, slings, chills, small castings, pieces of scrap are all salvaged while the burned cores, brick bats, etc., are discharged into an iron box for final disposition on the dump.



CONTINUOUS RIDDLING AND SEPARATOR PLANT OF LARGE CAPACITY

Make Ladle Nozzles in the Core Room

(*Concluded from page* 199)

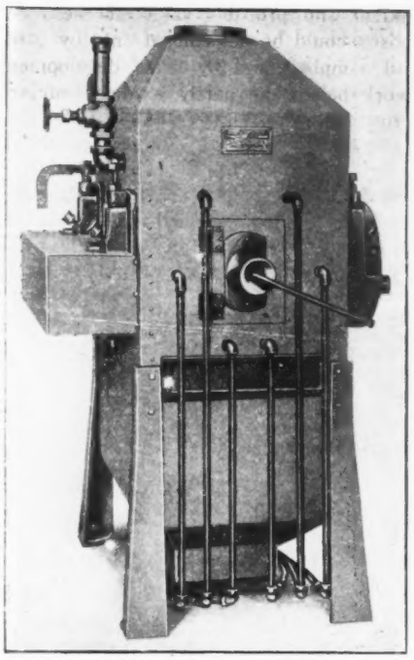
A is fastened to the rod in the usual way, as shown at *B*. Two burnt fireclay sleeves are then put on the rod and the whole covered with a fireclay wash after a nut has been screwed on the other end of the rod with a

collar between it and the clay sleeves. The hole in the end of the stopper is plugged with fireclay.

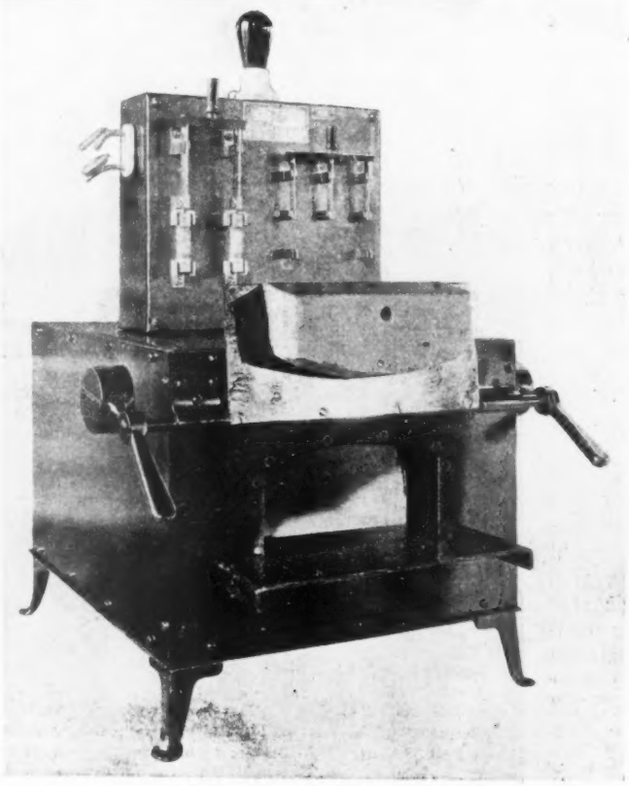
The nozzle, which is the special feature of this combination is made in the core room on a squeezer machine. It is formed of fireclay mixed with a small amount of sand. The nozzle is baked at the same temperature as cores, and so is not as strong as if it were burned at a higher temperature as are the nozzles sold for the trade in general. This nozzle is reinforced with a cast-iron ring, one of which is shown at *C* in the illustration on page 199. The nozzle, shown at *D*, gives a view of the side to be supported by the cast-iron ring. In the center of the illustration the mold for casting the rings is shown. This is made of cast iron and many rings can be cast in a short time as the metal sets almost immediately and the mold then may be emptied and made ready for another casting. Underneath the mold may be seen one of the rings and a pile of metal which has dripped off the mold from time to time as it was poured.

New Electric Heat-Treating Muffle Furnace

An electric furnace of the muffle type for baking vitreous enamel, hardening and tempering tools at temperatures up to 850 degrees Cent., has been developed by the General Electric Co., Schenectady. It consists of a furnace chamber with a control panel provided at the front. The heating element which is mounted on the outside of the muffle and covered with insulating compound is placed so as to give an even distribution of heat throughout the inside. The heating device is divided so that it is possible to get two gradations of temperature, which for convenience are known as high and low heat. The former is used to give a high initial heat, so that the maximum temperature may be reached quickly. In ordinary operation this maximum is reached in 1¼ hours after which the low heat is sunfficient to maintain an even temperature. The muffle is mounted in a strong steel casing and the walls, top, bottom and door, are thoroughly insulated, thus decreasing the loss of heat through radiation. The control panel is equipped with a main line switch, a double throw switch for high and low heat, and a red pilot lamp which acts as a warning to the operator when the furnace is on high heat. Connections on the side of the panel are provided to connect rheostats when temperatures as low as 300 degrees Cent. are desired. These features permit an adequate control of the temperature. The pilot lamp is installed to prevent destruction of material due to carelessness or inability on the part of the operator to estimate what temperature is being carried. The furnace is provided with a shelf in front and the door is balanced by counterweights to keep it open. When on high heat, the furnace requires 4 kilowatts to bring it up to 850 degrees Cent.



SMALL SAND BLAST CABINET FOR RODS



ELECTRIC FURNACE HAS RANGE OF TEMPERATURE FROM 300 TO 850 DEGREES CENT

Cabinet Type Sand-Blast for Cleaning Rods

A cabinet equipment recently produced by the Pangborn Corp., Hagerstown, Md., and shown in the accompanying illustration is devised to sand blast various shaped rods from ⅜ to ⅞-inch in diameter. The device embodies novel features of continuous operation with hygienic construction for the protection of the operator. The blasting chamber is entirely enclosed, and therefore the machine may be operated in the vicinity of machine tools without danger of damage from flying dust and abrasives. A set of rolls and guides at each end of the cabinet drives the rods at a uniform rate of speed through the blasting zone. The feed rolls are shaped to handle rods of any shape and diameter from ⅜ to ⅞ inch. The stream of abrasive enters the blast chamber through six projectors centering to the rod at a 45 degree angle and acting on the entire surface. The discharge is directed toward or into a small chamber that utilizes the rebound effectiveness of the abrasive. It is stated that scale has been removed from ¾-inch diameter rod with 80 pounds air pressure at a speed of 50 linear feet per minute. The bottom of the cabinet forms a hopper for storing the abrasive. The blast action is the suction type and individual feedboxes, in plain sight of the operator, supply each blast nozzle. Connection to an exhaust system removes disintegrated material. The cabinet is adapted for use with either sand or metal abrasive. It stands 69 inches high and occupies a floor space of 45 x 51 inches.

The P. H. & F. M. Roots Co., Connersville, Ind., manufacturer of blowers, contemplates selling its present foundry with all equipment.

Nickel Found in Alaska

Nickel minerals have geen found at various localities in Alaska, but none of the deposits has yet been worked. One group of these deposits is described in a recent publication of the U. S. geological survey, department of the interior, entitled "Nickel Deposits in the Lower Copper River Valley, Alaska," by R. M. Overbeck. The ore minerals are sulphides which have been altered by weathering. A selected specimen of this sulphide ore analyzed in the survey laboratory showed 7.23 per cent nickel. A number of rusty croppings on Canyon creek have been staked and assays are reported to show a small percentage of nickel. A specimen of sulphide ore from one of these croppings showed a minute trace of nickel when tested. The extent and probable value of these deposits could be determined only by careful sampling and by some development work below the partly oxidized surface cropping.

Moves to Philadelphia

The T. W. Price Engineering Co., designers and constructors of steel plants and foundries, has moved its main office from the Woolworth building, New York, to Philadelphia, and its drafting room to New Brunswick, N. J. Until the necessary accommodations in Philadelphia can be obtained, the main office of the company temporarily will be located in New Brunswick. The company will maintain New York small sales offices.

Purchases New Furnace

The Standard Brake Shoe & Foundry Co., Pine Bluff, Ark., has purchased a 1½-ton electric furnace from the Greene Electric Furnace Co., Seattle, and will install it with other equipment in a new steel and concrete building now under construction. The new furnace will be used to supply steel for a new type cast-steel plate back for locomotive-driver brake shoes, and also for general steel jobbing work.

The Westerly Brass Co., Westerly, R. I., recently has incorporated under the laws of Rhode Island and plans extensive plant changes and additions which will include compressors and electrical equipment.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

The Rock Island Mfg. Co., Rock Island, Ill., is building an addition to its foundry, 80 x 120 feet.

Plans are being drawn for the erection of a plant for the Cooper Brass Works, Ogdensburg, N. Y.

The Southern Stove Works, Inc., Richmond, Va., is reported planning the erection of a stove foundry.

The Cameron Stove Co., Richmond, Va., has under consideration the erection of a foundry.

Capitalized at $50,000, the Peru Brass & Mfg. Co., Peru, Ind., recently was incorporated by Ernest Theobald, Oscar Theobald and John T. Knott.

Fire recently damaged the plant of the Alliance Brass & Bronze Co., Alliance, O. The pattern room and offices escaped damage.

Waldron & Van Winkle, New York, industrial engineers, will take bids shortly for the erection of a 100 x 500-foot foundry for the Windsor Foundry Co., Windsor, Vt.

The Magnetic Mfg. Co., Milwaukee, manufacturer of separators for foundries and smelters, is building a plant, 60 x 120 feet.

The Enterprise Foundry Co., Charles Crowlin, 1127 Griswold avenue, Detroit, contemplates the erection of a cupola building, 35 x 40 feet.

The Standard Steel Casting Co., 910 South Michigan avenue, Chicago, contemplates the erection of two buildings, each 70 x 250 feet.

The National Bronze & Aluminum Foundry Co., 2639 East Seventy-ninth street, Cleveland, is reported planning the erection of a plant addition.

Einar Owren, Charles M. Robbins and W. A. Briggs are the incorporators of the Owren Casting Co., Attleboro, Mass., which was recently chartered with $10,000 capital.

Capitalized at $25,000, the Danbury Foundry Co., Inc., Danbury, Conn., recently was chartered by R. J. Hansin, E. Hansin and W. H. Cable.

The Rome Brass & Copper Co., Rome, N. Y., is reported planning to make alterations to its office building.

O. Z. Vannoy was named among the incorporators of the Economy Stove Co., Greenville, O., which was recently incorporated with $75,000 capital.

The O. K. Stove & Range Co., Louisville, Ky., plans the erection of plant additions, including a foundry.

Plans are being prepared for the erection of an addition to the foundry and pattern shops of the Pomona Mfg. Co., Pomona, Cal.

Erection of a machine shop and foundry, is reported being planned by the Baltimore Valve Co., Baltimore.

The Barnett Foundry & Machine Co., Lyons avenue, Irvington, N. J., has had plans prepared for the erection of an addition to its plant.

Robert Perlick, brass founder, 194 Reed street, Milwaukee, has incorporated under the style, R. Perlick Brass Co., with a capital of $15,000.

The Kewanee Boiler Co., Kewanee, Ill., is building several additions to its plant. They are additions to the boiler shop and foundry.

The W. M. Crane Co., Garfield avenue, Jersey City, N. J., manufacturer of stoves has awarded a contract for the erection of a plant to include a foundry.

The James T. Clark Co., 70 Adams street, Newark, N. J., contemplates the erection of an addition to its foundry.

The J. C. Eichman Mfg. Co., Bish and Wicomico streets, Baltimore, is planning the erection of an addition to its foundry, 40 x 40 feet.

Contracts for the erection of a foundry building, 65 x 400 feet, an administration building, 50 x 90 feet, a power house and a crusher plant, have been let by the Simbroco Stone Co., Boston.

The plant of the Bridgeport Castings Co., Bridgeport, Conn., which was recently damaged by fire, will be rebuilt at once. The new structure will cover 22,000 square feet.

The P. B. Yates Machine Co., Beloit, Wis., will start construction of a gray-iron foundry, 206 x 264 feet, and also will undertake enlargement of its machine shops.

An addition to its gray-iron foundry, 220 x 300 feet, is being erected by the Kohler Co., Kohler, Wis. An engineering building, 130 x 262 feet, is also being built.

Capitalized at $10,000, the Schmitt Brass Foundry Co., Columbus, O., recently was chartered by G. W. Schmitt, Ed. Schmitt, S. F. Deardof, G. M. Schmitt and C. V. Dehnoof.

Erection of an addition to the foundry of the Gisholt Machine Co., Madison, Wis., is expected to be started shortly. The building will be 113 x 200 feet.

Plans are being prepared by the Lakey Foundry Co., Muskegon, Mich., a branch of the Continental Motors Corp., for the erection of an addition to its foundry, which will practically double the capacity of the plant.

The Northwest Foundries, Inc., Villa and Valentine streets, Rochester, N. Y., has had plans prepared for the erection of a gray-iron foundry, 197 x 250 feet, George A. Hetzler is secretary and general manager.

Plans are being prepared for the erection of an addition to the plant of the O. B. North Co., New Haven, Conn., manufacturer of castings. The building will be 37 x 110 feet.

Maidsof & Ashton, Troy, N. Y., have been incorporated to engage in the manufacture of iron and steel castings with $15,000 capital, by H. M. Ashton, J. E. McNary and J. L. Maidsof.

The Pattern Foundry & Equipment Corp., New York, has been incorporated with $10,000 capital, by S. H. Selig, J. Sachs and A. L. Ross, 665 West 160th street.

Capitalized at $500,000, the Lima Foundry & Machine Co., Lima, O., recently was incorporated under the laws of Delaware, by T. L. Croteau, C. H. Blaske and S. E. Dill of Wilmington, Del.

The Albrass Co., Albany, N. Y., recently was incorporated with $25,000 capital, to engage in foundry work, by E. W. Leahy, J. Erickson and F. A. W. Griesau.

W. J. Hickey, 119 Main street, Welland, Ont. has been awarded the contract to rebuild the plant of the Welland Iron & Brass Co., which was recently damaged by fire.

The Hoffman Heater Co., Lorain, O., which recently completed the erection of a new plant, is reported considering the erection of a foundry addition to its plant, within the year.

H. Kramer & Co., Inc., 1224 West Twenty-first street, Chicago, is building a foundry, 127 x 200 feet, a warehouse, 30 x 85 feet, and an office building, 58 x 65 feet.

The Erie Rubber Mold & Machine Co., Sandusky, O., recently was incorporated by A. E. Rogers, A. J. Jejsa and others, and will establish a plant. The company is capitalized at $10,000.

The Sully Brass Foundry, Ltd., Toronto, Ont., recently was incorporated with $40,000 capital, by

George H. Sedgewick, John W. Pickup and James Atchison.

The Cook-Lewis Foundry Co., Greensboro, N. C., brass products, recently was incorporated with $50,000 capital, and plans are being prepared for the erection of a plant, 40 x 75 feet.

The Independent Brass Works, Center and Walnut streets, Louisville, Ky., has closed a contract for the erection of a building to increase its foundry space.

The Mont-Clare Foundry Co., Philadelphia, recently was incorporated with $50,000 capital, by Clare M. Borton, 114 Park Row, Horace E. Frick, 806 South Forty-ninth street, and Randolph Sailer, 929 Chestnut street.

Local capital at Milwaukee is organizing the American Foundry Co., which will be incorporated with $100,000 capital. It is reported plans are being prepared for the erection of a gray-iron foundry for the production of light castings.

The Buckeye Brass & Mfg. Co., Harry Selker, president, 6410 Hawthorne avenue, Cleveland, is having plans drawn for the erection of a furnace room and foundry, 30 x 110 feet and 75 x 75 feet respectively.

Announcement has been made that the Battle Creek Jobbing Foundry, Battle Creek, Mich., which was formerly located at Galesburg, Mich., plans to enlarge its foundry and install a cupola to melt 12 tons per hour.

The Columbia Sanitary Mfg. Co., Louisville, Ky., manufacturer of bathtubs, plumbing goods, etc., has tripled its stock to $300,000, and has announced plans for doubling the capacity of its foundry and the other departments of its plant.

The Illinois Malleable Iron Co., which purchased a 43-acre site at Louisville, Ky., has not done anything with the property as yet, but is reported planning to go ahead with the erection of a large plant in the spring.

The South Side Malleable Castings Co., Fourteenth and Windlake streets, Milwaukee, is making improvements to its plant. The most important items of new equipment to be installed are three 5-ton charging cranes, and a craneway over the furnaces.

The Valley Iron Works, Appleton, Wis., which doubled the size of its foundry and machine shop during the war, is erecting further additions which will increase its capacity about 50 per cent. Some contracts for additional foundry and machine shop equipment are being placed.

Formation of the Gartland-Haswell-Rentschler Foundry Co., at Dayton, O., has been announced. The company will take over the complete foundry organization of the Platt Iron Co., according to reports from Dayton. Gordon S. Rentschler is head of the new firm.

The Olympia Foundry Co., Olympia, Wash., recently was incorporated by W. L. Phillips, William Allard and others. The company for the present will engage in the manufacture of gray iron castings, but plans to later on add the manufacture of brass castings to its line.

The Machinery & Foundries, Ltd., Brockville, Ont., has been incorporated to carry on business as iron founders, steel makers, etc., with $250,000 capital. The company will start work in the spring on the erection of a foundry. Directors of the company are: James C. Gardner, George E. Purkis, Joseph R. A. Laing and others.

Contract has been awarded for the erection of a foundry for Williams, White & Co., Moline, Ill. The building will be 150 x 325 feet, with a covered material bay, 400 feet long. The Clement A. Hardy Co., Chicago, is acting as consulting engineer on the project, and has purchased the necessary structural steel.

The Rabe Pipe & Foundry Co. has been organized at Chattanooga, Tenn., with a capital of $200,000, to engage in the manufacture of soil pipe and plumbing supplies. Incorporators are former County Judge Will Cummings, R. R. Rabe, Clifford Fryar, W. H. Cheney and T. Pope Shepard. Work on the erection of a new plant will be started at once. It will employ about 150 men.

The New Process Copper Castings Co. recently was incorporated under the laws of Delaware with a capital of $100,000, by John Mellor, president; James Smith, vice president and general manager, and John C. Bramer, secretary-treasurer. The company will engage in the manufacture of bronze and copper castings, specializing in castings for blast furnace equipments.

The J. I. Case Plow Works Co., Racine, Wis., is erecting two foundries and a warehouse as additions to its plant. The gray-iron foundry is 126 x 360 feet, the malleable plant, 150 x 300 feet and the warehouse, 122 x 140 feet. This work is in charge of Foltz & Brand, Conway building, Chicago, architects and engineers. C. D. Bidwell is engineer in charge of maintenance for the company.

The National Farming Machinery, Ltd., Montmagny, Que., which recently acquired the plant of the General Car & Machinery Works, will build extensions to the plant and install new equipment. The company will continue the manufacture of steam engines and boilers, sawmill and woodworking machinery. It will also operate steel, iron, brass and aluminum foundries. A small rolling mill is among the improvements.

The Alloy Electric Steel Casting Co., which was recently incorporated at Columbus, O., with $300,000, plans to erect a plant at Warren, O., for the manufacture of automobile parts and general castings. The plant will be equipped with several electric furnaces. The first building of the proposed plant will be 110 x 200 feet, and construction will be started about April 1. Jacob Coxey, Massillon, O., and his two sons, H. L. and J. S. Jr., are behind the project.

Contractors have started on the erection of a foundry, to be devoted exclusively to the manufacture of high grade light and medium weight commercial gray-iron castings for the Advance Castings Co., Goshen, Ind. The first unit consists of a molding room, 70 x 196 feet, with core room, cupola room, blower room and pattern storage room adjoining the main foundry. The company recently was incorporated with $50,000 capital. S. E. Schucht is president and treasurer of the company.

The Shawinigan Foundries, Ltd., Shawinigan Falls, Que., has acquired the electric furnace plant of Braser Bruce & Co., as well as the iron foundry formerly operated by Normandin Bros. Additions to the plant are under contemplation, and arrangements are being made for carrying on brass foundry work and putting a special grade of semisteel castings on the market. G. G. McCartney is president of the company; W. G. Dauncey, vice president, and C. M. Hall, secretary.

Erection of a gray-iron foundry, 100 x 160 feet, as an extension to the plant of the Dominion Steel Products Co., Ltd., Brantford, Ont., has been started. The foundry will be equipped with the most modern foundry equipment, including a 20-ton air furnace and two cupolas. It is expected the plant will be ready for occupation some time in March. The output of this plant will consist of a general line of castings; rolling mill equipment, rolls, rubber working machinery, rubber mill and calender rolls, and cores and molds.

Ira L. Houghton, Toledo, O., formerly president and general manager of the Maumee Malleable Castings Co., Toledo, O., has organized the Houghton Malleable Castings Co., with an authorized capital of $500,000, and will locate in Toledo on a 25-acre tract. The construction of the first plant unit will be started early in March. This building, which will cover about 150,000 square feet of floor space, will house three 35-ton air furnaces, core and annealing ovens. The buildings will be of steel and glass construction, and contracts for new equipment will be let shortly. The office of the company is at 965-966 Spitzer building, Toledo.

New Trade Publications

INDUSTRIAL PIPING.—A booklet, entitled "Inter-Related Industries," is being circulated by Grinnell Co., Inc., Providence, R. I., in which a brief story of 70 years development of several inter-related industries, founded on industrial piping, is given. The booklet is interesting and contains a number of illustrations of the company's various plants.

PNEUMATIC TOOLS.—The Independent Pneumatic Tool Co., Chicago, has issued a circular, describing its pneumatic tools. The circular points out that the drills are the only ones manufactured in this country having Corliss valves, and also states that they have one piece pressed steel connecting rods and pistons. Roller bearings on each end of the crank shaft reduce friction.

BUCKETS.—The Industrial Works, Bay City, Mich., is circulating an illustrated booklet, in which clam-shell buckets, which it manufactures, are described and illustrated. These buckets have hardened steel bushings in lower ends of connecting rods; steel rope guard extending completely around power wheel to prevent fouling of the closing line; large heavy power wheel, bushed; hard alloy steel idler sheave, bushed; closing line, guarded against chafing; opening line does not enter bucket and steel shaft bearings. Other parts of the buckets are described. Illustrations show the buckets in actual use.

ALLOY STEELS.—The Climax Molybdenum Co., New York, has published an illustrated booklet, in which the development, history, use, etc., of molybdenum steels, are given. The booklet is profusely illustrated, and contains a number of interesting tables, and other data showing tensile strength, physical properties, etc., of the various molybdenum steels. According to the booklet, molybdenum does not volatilize nor oxidize out of the bath and the metal can be introduced into steel as easily as any other alloy. Methods of making molybdenum steel by the open hearth and electric furnace processes are given in the booklet. The booklet should be of interest not only to steel markers, but steel products manufacturers as well. According to the booklet, before publication of the data which it contains, the company submitted all data to officials and metallurgists of some of the largest alloy steel manufacturers and consumers in the country, to pass on the statements.

CHIMNEYS.—An illustrated booklet has been published by the Portland Cement association, in which concrete chimneys for use at industrial plants are described and illustrated. The illustrations show chimneys at the plants of the Havana Railway, Light & Power Co., Havana, Cuba; Peet Bros. Mfg. Co., Berkeley, Cal.; the Minnesota By-Products Coke Co., St. Paul; the Excelsior Motor Mfg. & Supply Co., Chicago; the Brown Shoe Co., St. Louis; the Burnside, Ill., shops of the Illinois Central railroad, and the Saganoseki Copper Co. smelter at Saganoseki, Japan. Each illustration is accompanied with dimensions and other data.

PYROMETERS.—The Brown Instrument Co., Philadelphia, has published an 88-page illustrated booklet in which pyrometers are described and illustrated. The pyrometer consists of a thermo-couple and a galvanometer. The thermo-couple is formed of two wires of different alloys, joined at one end, and when this junction is heated it generates a small current of electricity. The current is sufficient to operate an electrical instrument or millivoltmeter. As the temperature of the thermo-couple rises and falls, the thermo-electric current increases or decreases, and is indicated on the instrument in degrees Fahrenheit, Centrigrade or in millivolts. The use of this instrument in heat treating plants, blast furnaces, glass plants, ceramic kilns, cement plants, for finding the correct temperature of molten metal in foundries, and in various other industrial plants is described. The construction of the various types of pyrometers and their accessories are described and illustated in detail.